Engineering Library

Printed on Thin Paper for Foreign Circulation.

MAY 15 1922

The Engineer.

Established 1856.

Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 33, NORFOLK ST., STRAND, LONDON, W.C. 2.

VOL. CXXXIII.—No. 3460] LONDON: FRIDAY EVENING, APRIL 21, 1922 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

University College of Swansea.

APPLICATIONS are INVITED for the POST of LECTURER in CIVIL ENGINEERING. Salary £500 per annum. The appointment will date from October 1, 1922.

Further particulars may be obtained from the undersigned, by whom applications must be received on or before May 15, 1922.

EDWIN DREW,
Registrar.

Singleton Park, Swansea,
April, 1922. 7989

PATENTS AND DESIGNS ACTS, 1907 AND 1919.

GEAR-CUTTING MACHINES.

The Proprietors of British Letters

Patent No. 2939 of 1915 are PREPARED to SELL the PATENT or to LICENSE British manufacturers to work under it. It relates to spacing and feeding mechanism for gear-cutting machines, in which irregularities in the driving worms and wheels are compensated, whereby uniform angular movement of the work support is produced.

Address,

B. W. & T.,
111 and 112, Hatton-garden,
7996 London, E.C. 1.

Borough of Beverley.

SEWERAGE WORKS.
CONTRACT NO. 2.

The Council is prepared to receive TENDERS for the CONSTRUCTION of SEWERS, SCREENING and PUMP WELL, TANKS, CHANNELS, SUBWAYS and WELLS, ENGINE-HOUSE, PUMPING PLANT, and ALTERATIONS and ADDITIONS to existing BUILDINGS and TANKS at their Sewage Disposal Works, Beck Side; an EFFLUENT OUTFALL PIPE to the river Hull, and also certain MAIN SEWERS in the Borough of Beverley.

The drawings, specification, and bill of quantities can be inspected at the office of the Engineer, Mr. William Fairley, Parliament Mansions, Westminster, S.W. Copies may also be inspected at the office of the Borough Surveyor, Mr. J. Gould Smith, Lairgate, Beverley.

A limited number only of copies of the bill of quantities are available for issue to approved contractors on application at either of the above offices.

Sealed Tenders to be lodged with the undersigned on or before Noon on Friday, the 5th May, 1922.

The Council does not bind itself to accept the lowest or any Tender.

J. DENNETT,
Town Clerk.

Town Clerk's Office,
Lairgate, Beverley,
19th April, 1922. P5247

The Corporations of Middlesbrough, Thornaby-on-Tees and Stockton-on-Tees,

having taken over the undertaking of the Imperial Tramways Company, Limited, in the three boroughs, have FOR SALE PORTIONS of the LAND, BUILDINGS, MACHINERY and PLANT which are not required by the Corporations in connection with the running of the tramway undertaking subsequent to the transfer.

The particulars are as follows:—

(1) Buildings utilised by the Imperial Tramway Company for the purpose of generating electricity and consisting of:—

Power-house, measuring or containing 335,610 cub. feet.
Boiler-house containing 193,031 cub. feet.
Offices containing 21,546 cub. feet.
Smokestack of best pressed bricks and lined with fire-bricks.
All necessary Foundations for the Machinery.
A Wharf, 200ft. long, abutting on the River Tees, constructed of pitch pine timber and red deal, with 336 sq. yds. of slag pitching.
Boundary Walls, together with Freehold Land, upon which the buildings are erected and adjacent and incident thereto, containing 426 sq. yds. or thereabouts.

The buildings are built of best pressed brick, the power-house being lined with glazed bricks.

The Power Station is equipped with 3 Corliss Horizontal Compound Condensing Engines, direct coupled to 3-phase, 25-cycle, 2500-volt Generators; 2 Rotary Converters, 25 cycle, wound to give 500 to 550 volts on D.C. side; Rotary Converter Booster, Switchboard, Overhead Travelling Crane, Motor-driven Centrifugal Circulating Pump, 3 Babcock and Wilcox Boilers, evaporation 12,000 lb., with Vickers Mechanical Stokers; Electric Motor for driving Mechanical Stokers, Green's Economiser, Coal Bunkers, Coal Elevator (fitted with Avery's Automatic Weighers), Electric Grab Crane, Cables, Piping, Electric Lighting Equipment, and other forms of Plant and Machinery necessary for a fully equipped Electricity Generating Station.

The whole of the above are situate and adjacent to Bridge-road, Stockton-on-Tees, and abut upon the River Tees a little to the west of the Victoria Bridge, which crosses the Tees at or near to that point.

The buildings, which were erected about 22 years ago, are built in a most substantial manner and are in good order and condition.

The plant has likewise been kept in first-class running order.

In addition to the above there is also for sale:—

(2) Plant and Machinery in the Newport Sub-station situate in Newport-road, in the Borough of Middlesbrough, consisting of:—

3 Rotary Converters, Single-phase Air-cooled Transformers, Centrifugal Fans, Electric Motors, Switchboard (13 panels), and all necessary Cables.

(3) Also the following Plant now at Bridge-road premises, Stockton-on-Tees:—

Weighbridge, Hydraulic Lifting Jack, Axle Tester, Hydraulic Rail Bender, Hydraulic Punching Bar, Wells' Light, Snow Sweeper, Hand Ambulance.

TENDERS are INVITED for the PURCHASE of:—

(1) The LAND, BUILDINGS, MACHINERY and PLANT as described above, situate in or near to Bridge-road, Stockton-on-Tees.

(2) The PLANT and MACHINERY at the Newport Sub-station.

(3) The MISCELLANEOUS PLANT; or, alternatively, Tenders under the head of 1, 2 and/or 3 separately, or any two of them.

Particulars and conditions of sale and permission to view can be obtained from the undersigned, to either of whom sealed Tenders must be sent not later than May 30th, 1922.

Please mark envelopes "Tenders for Tramway Premises or Plant."

The Corporations give no undertaking to accept either the highest or any other Tender or Tenders that may be sent in.

PRESTON KITCHEN,
Town Clerk and Clerk to the Tramways Committee, Municipal Buildings, Middlesbrough;
THOS. DOWNEY,
Town Clerk and Clerk to the Stockton and Thornaby Joint Tramways Committee, Borough Hall, Stockton-on-Tees,
6th April, 1922. 7938

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

Chinese Engineering Notes.
International Railway Association.
Battery Locomotives for Industrial Purposes.
German Submarine Building during the War.
Diesel Machinery for Single-Screw Ships.
Pacific Type Locomotives.
New Type of Concrete Truss Bridge.
Cotton Research Institute.
Locomotive Economy.
Industry and Economics.

PUBLIC NOTICES

Bombay, Baroda, and Central India Railway Company.

The Directors are prepared to receive up to Noon on Friday, 12th May, TENDERS for the SUPPLY of:—

1. GOODS WAGONS.
2. WHEELS AND AXLES.

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 20s. each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Secretary.

Offices: The White Mansion,
91, Petty France,
Westminster, S.W. 1,
19.4.22. 8013

City of Oxford.

RECONSTRUCTION OF PACEY'S BRIDGE.

The Oxford City Council invite TENDERS for the REBUILDING of PACEY'S BRIDGE. The work consists of Pile Foundation, Masonry, and Steel Superstructure.

Plans may be seen and particulars obtained at the office of the City Engineer, J. E. Wilkes, Esq., A.M.I.C.E., Town Hall, Oxford.

Specification, quantities, and form of Tender may be obtained upon application to the City Engineer on payment of a deposit of Five Pounds, such sum to be returned on receipt of a bona fide Tender.

Tenders, in sealed envelopes, addressed to me and endorsed "Pacey's Bridge," must be delivered at my office on or before Noon on Monday, 1st of May next.

The lowest or any Tender will not necessarily be accepted.

A. H. MONTGOMERY,
Deputy Town Clerk.

Town Hall, Oxford,
10th April, 1922. 7946

East Indian Railway.

The East Indian Railway Company is prepared to receive TENDERS for the SUPPLY and DELIVERY of:—

WROUGHT IRON (Billets, Flats, Rounds, and Squares),

as per specification to be seen at the Company's offices. Tenders are to be sent to the undersigned, marked "Tender for Wrought Iron," not later than Eleven o'clock a.m. on Wednesday, the 3rd May proximo.

The Company reserves to itself the right to divide the order, also to decline any Tender without assigning a reason, and does not bind itself to accept the lowest or any Tender.

For each specification a fee of £1 1s. is charged, which cannot under any circumstances be returned.

By Order,
G. E. LILLIE,
Secretary.

Nicholas-lane, London, E.C. 4,
19th April, 1922. 8011

Egham Urban District Council.

The Egham Urban District Council invite TENDERS for the SUPPLY and DELIVERY of ONE VACUUM CESSPOOL EMPTYING MACHINE with interchangeable haulage body (side and end tip).

Full particulars and Tender form can be obtained on application to the Surveyor at his office, Council Offices, Egham, Surrey.

Tenders to be delivered in sealed envelopes, endorsed "Tender for Vacuum Cesspool Emptying Machine," to the undersigned not later than Ten o'clock on Saturday, 29th April, 1922.

The Council do not bind themselves to accept the lowest or any Tender.

GEO. W. BOOTH,
M. Inst. M. and Cy. E.,
Surveyor.

Council Offices,
155, High-street,
Egham, Surrey. 7957

PUBLIC NOTICES

Port of Bristol.

GRAIN HANDLING MACHINERY, NEW GRANARY, ROYAL EDWARD DOCK, AVONMOUTH.

The Docks Committee are prepared to receive TENDERS for the CONSTRUCTION and ERECTION on site of GRAIN HANDLING MACHINERY for the New Granary, Royal Edward Dock, Avonmouth. The machinery consists of Elevators and Conveyors and includes Motors and Switchgear for driving the same.

On and after Friday, the 28th April, 1922, copies of the specification and contract drawings can be obtained from the undersigned on production of a receipt showing that a deposit of £5 has been paid. All cheques must be made payable to "The Bristol Docks Committee" and forwarded to the General Manager and Secretary, Dock Office, 19, Queen-square, Bristol. The deposit will be returned to bona fide tenderers after the receipt of the Tender with all the prescribed documents and drawings.

Tenders must be enclosed in a sealed envelope, endorsed "Tender for Grain Handling Machinery," and addressed to the General Manager and Secretary of the Docks Committee, 19, Queen-square, Bristol, and must be delivered to him, accompanied by all the prescribed documents and drawings, before 10 a.m. on Tuesday, the 23rd May, 1922.

The Docks Committee do not bind themselves to accept the lowest or any Tender.

THOMAS A. PEACE,
Engineer.

Engineer's Office,
Avonmouth Docks,
20th April, 1922. 7984

Richmond Main Sewerage Board

CONTRACT FOR STORES.

The Board are prepared to receive TENDERS for the SUPPLY and DELIVERY to their works during the year ending May 31st, 1923, of the following STORES:—

STEAM COAL (Welsh).
GREY LIME.
BUXTON LIME.
SEWAGE PRECIPITANTS.
FILTER PRESS CLOTH.

Specifications may be inspected and further particulars obtained at the office of Mr. William Fairley, M. Inst. C.E., Engineer to the Board, West Hall-road, Kew Gardens, Surrey.

Sealed Tenders, on the forms provided, to be delivered to the undersigned on or before Tuesday, May 9th, 1922.

The Board do not bind themselves to accept the lowest or any Tender.

J. LESLIE G. POWELL,
Clerk to the Board.

The Sessions House,
Richmond, Surrey,
12th April, 1922. 7983

Siamese State Railways.

NOTICE.

TENDERS are INVITED for SUPPLY of RAILS and PERMANENT WAY ACCESSORIES.

Specifications and drawings may be obtained against payment of £1 from Messrs. C. P. Sandberg, 49, Grosvenor-gardens, London, S.W. 1.

Sealed Tenders, with the inscription "Tender for the Supply of Rails and Permanent Way Accessories, B.E. 2465," must be forwarded to the undersigned, at whose office in Bangkok, Siam, they will be received up to 2 p.m. on the 31st of July, 1922, at which place and hour the Tenders will be publicly opened and read.

Right is reserved to reject any or all Tenders and to accept any Tender which, in the opinion of the undersigned, is to the best interests of the Siam State Railways.

(Signed) GENERAL PURACHATRA,
Commissioner-General of State Railways,
Department of State Railways,
Bangkok, 25th February, 1922. 7994

Salford Union Infirmary

(NURSES' HOME), HOPE, PENDLETON, MANCHESTER.

TENDERS are INVITED for the SUPPLY and ERECTION of a new type "Ideal" WATER HEATING BOILER, capable of generating at least 604,800 B.T.U. per hour and with direct radiation of 4185 sq. ft., complete with draw-off cock and stoking tools.

Tenders, accompanied by specification and drawing, to be sent to undersigned as early as possible.

By Order,
E. H. INCHLEY,
Clerk to the Guardians.

Poor Law Offices,
Eccles New-road, Salford,
19th April, 1922. 8012

Tenders are Invited by the

Government of New South Wales for the CONSTRUCTION of the SUPERSTRUCTURE and SUBSTRUCTURE of a CANTILEVER BRIDGE across Sydney Harbour from Dawes Point to Milson's Point, embracing a main span of 1600ft. in the clear, centre to centre of main piers, or 2600ft. centre to centre of anchor piers. The total length of bridge included in Tender is 3816ft., centre to centre of abutments. The deck of the bridge is to include four lines of railway, and a roadway 35ft. wide, between main trusses; and cantilevered outside the main trusses on the western side, a footway 15ft. wide, and on the eastern side a motor roadway 16ft. wide. Copies of specification, including plans, general conditions and schedule of quantities may be obtained on application to the undersigned.

To give any information required by tenderers, Mr. J. J. C. Bradfield, Chief Engineer, will be in London during June and July, 1922, address care of the undersigned.

Tenders in accordance with the specification must reach the Under Secretary for Public Works, Sydney, not later than 31st October, 1922.

AGENT-GENERAL
FOR NEW SOUTH WALES.

Australia House, Strand, London, W.C. 2,
December, 1921. 7838

For Sale by Public Tender.

To close the 2nd of May, 1922.

The BUSINESS of THE BRITISH CARBONISING CO., Ltd., Manufacturers of Metallic Grinding Bodies and Appliances, and Proprietors of Valuable Patents in connection therewith.

The whole of the undertaking will be sold as a going concern. It is in full working order and at the present has an output of 10 tons per week, which should be considerably increased, there being a constant and increasing demand for the company's manufactures.

The premises are entirely freehold, the buildings are conveniently arranged and comprise factory, tool-room, store-room, yard, dwelling-house, with ground floor fitted as offices.

The premises will be on view from the 24th April to 1st May, 1922.

Full particulars with conditions of sale, forms of Tender, and permit to view, can be obtained on application to Mr. A. LIONEL LANE, Solicitor, or Messrs. DUART-SMITH, BAKER and PRICE, Accountants, all of Gloucester. 7931

Required for Service in the

Carriage and Wagon Department of the BOMBAY, BARODA and CENTRAL INDIA RAILWAY, ONE ASSISTANT FOUNDRY FOREMAN,

who must have had experience as a Furnace Operator and be acquainted with the Tropenas Steel Process. A knowledge of steel mixtures is essential. Preference will be given to a man who, in addition to the above qualifications, has had experience as a moulder. He should be capable of taking charge of a small steel foundry, and must be thoroughly reliable and steady. Age should not exceed 35 years.

Salary: Rs. 350, rising by annual increments to Rs. 400 per calendar month.

Terms: A three years' agreement in the first instance, second-class free passage to India and home again on satisfactory termination of service.

The selected candidate will be required to pass a strict medical examination by the Company's Consulting Physician before final appointment.

Letters of application, giving particulars of applicants' general and technical education, and showing in chronological order (with dates) where and how they have been employed from time to time, and also stating age and whether married or single, should be addressed to the undersigned not later than the 5th May, 1922.

Copies (not originals) of testimonials, &c., should be sent.

S. G. S. YOUNG,
Secretary.

Offices: The White Mansion,
91, Petty France,
Westminster, S.W. 1,
21st April, 1922. 8014

The National Foremen's Association of the

ENGINEERING AND ALLIED TRADES,

(Registered under the Trade Union Act.)

An Association specifically formed to look after the interests of Foremen in their Supervisory Capacity.

All communications to Head Offices,
H. W. REID, 95, Belgrave-road,
General Secretary, Victoria, S.W. 1.
Rev.

PUBLIC NOTICES (continued) Page II.

SITUATIONS OPEN, Page II.
SITUATIONS WANTED, Page II.
MACHINERY, &c., WANTED Page II.
FOR SALE, Pages II., III. and XCIV.
AUCTIONS, Pages III. and XCIV.
PREMISES TO LET OR WANTED Page XCIV.
WORK WANTED, Page III.
AGENCIES, Page II.
MISCELLANEOUS, Page II.

For Advertisement Rates See Page 443, col. 1.

NUMERICAL INDEX TO ADVERTISEMENTS, Page XCIII.

PUBLIC NOTICES

The Egyptian State Railways have a VACANCY for a DISTRICT LOCO. SUPERINTENDENT at a commencing salary of £E540 a year (consolidated pay). Public school education indispensable.

Applicants must have served a time in a railway workshop or in the workshops of a firm which constructs locomotives and, in addition, must have had some small position involving charge on a railway, preferably in the running department for a period of at least one year.

Applicants must be unmarried, age must not exceed 35 years.

Forms of application are to be obtained from the office of the INSPECTING ENGINEER, Egyptian and Sudan Governments, Queen Anne's Chambers, Westminster, S.W. 1. 7944

SITUATIONS OPEN

WANTED IMMEDIATELY, a MECHANICAL DRAUGHTSMAN, with experience in Water works and Vertical Pumping Engines. Six months' engagement. Apply, stating qualifications and salary required.—Address, J. C. HOWLEY, Engineer, Eastbourne Waterworks Company, 23, Seaside-road, Eastbourne. 8009 A

WANTED, TRAVELLER, with Experience in Handling Power Transmissions, Shafting, Pulleys and Bearings. State age and previous experience.—Address, 7985, The Engineer Office. 7985 A

A VACANCY OCCUES for a First-class SALES REPRESENTATIVE for the following territories:—(1) South Wales. (2) Lancashire and North Wales. (3) Yorkshire and South of Tweed. (4) Scotland. (5) Nottinghamshire and Midland Counties. (6) Ireland. Applicants must be first-class Engineers and Salesmen, accustomed to handling all kinds of new and second-hand machinery. Must be prepared to take up a nominal holding in the company. Only live men need apply.—Address, 8006, The Engineer Office. 8006 A

A WELL-KNOWN MOTOR CAR FIRM REQUIRES the SERVICES of a General MACHINE SHOP SUPERINTENDENT.—Address, giving age, salary required, and full details of experience, stating with what firms same has been gained and giving dates, 8007, The Engineer Office. 8007 A

ACCOUNTANT REQUIRED for West Africa. Age not over 35. Thorough knowledge accounts. Capable of installing and supervising complete system of steamers' running accounts and cost accounts for engineering and repair work.—Address, stating age, previous experience, and salary desired, P5246, The Engineer Office. P5246 A

CONSULTING ENGINEER REQUIRES an Experienced DRAUGHTSMAN accustomed to Design and Functioning of Modern Waterworks Machinery and Ironwork, including Engines, Pumps, Boilers, Superheaters, Valves, Pipes, &c., whether for intakes, deep wells, or reservoirs.—Address, stating age, experience, and remuneration sought, 7993, The Engineer Office. 7993 A

CONTROL APPARATUS DESIGNER.—Experienced MAN REQUIRED, capable of working out designs of Traction Control Apparatus from a specification with scheme of connections; experience of modern locomotive control gear essential; knowledge of manufacturing methods an advantage; must be good disciplinarian. State age, technical training, experience, and salary required.—Address, 7967, The Engineer Office. 7967 A

WANTED by a Port Authority, a Fully Qualified CHIEF DRAUGHTSMAN in the Chief Engineer's Office, age about 35/40 years. Salary £700 per annum. Applicants should state fully their experience in designing and construction of docks, buildings, constructional steel work, bridges, reinforced concrete, surveying and quantity surveying, also if disengaged or how soon they could take up duty. Applicants should be competent take control of drawing-office staff and should state fully their experience accompanied by references.—Address, 7995, The Engineer Office. 7995 A

DRAUGHTSMAN, First-class Man, with Knowledge of Ship Construction and Design, WANTED, for one or two years' engagement in South America; preference to a single man. State age, experience, and salary required.—Address, 7970, The Engineer Office. 7970 A

LEADING DRAUGHTSMAN REQUIRED, with first-class experience of Horizontal Airless Injection Oil Engines. State experience, age, salary, and when at liberty.—Address, 7987, The Engineer Office. 7987 A

MACHINE TOOL DRAUGHTSMAN REQUIRED in East Anglia. One who has had some practical experience with good firm manufacturing Planing Machines or similar machines of this character; good opportunity for first-class man.—Apply, stating age, experience, and salary required, to Box 231, W. S. Crawford, Ltd., 233, High Holborn, London, W.C. 1. 7999 A

TWO or THREE TEMPORARY DRAUGHTSMEN REQUIRED for Preparing Shop Details of Structural Steel Work. State previous experience, age, and salary required.—Address, 8008, The Engineer Office. 8008 A

SITUATIONS WANTED

A CARRIAGE and WAGON ENGINEER (32) SEEKS RE-ENGAGEMENT about month's time. Position as assistant works manager, superintendent, or of administration, estimating, buying, design, production, inspection, home or abroad.—Address, P5248, The Engineer Office. P5248 B

ADVERTISER (Age 36), 22 Years' Experience of marine, motor, and general engineering, 5 years foundry manager, 5 years foreman patternmaker, is OPEN for ENGAGEMENT in any capacity where tact, energy, and ability are required. Good references.—Address, P5254, The Engineer Office. P5254 B

AN ENGINEER, Experienced in Irrigation, Railways, docks, and river embanking, will shortly be disengaged and DESIRES fresh ENGAGEMENT. Highest references.—Address, P5243, The Engineer Office. P5243 B

AS CHIEF or ASSISTANT ENGINEER in Experimenting and Patenting Departments (long experience in every phase of patenting work), Representative, Draughtsman, or Technological Secretary.—Address, P5273, The Engineer Office. P5273 B

BUYER.—The MANAGER of a Large Engineering Works Purchasing Dept., who has an exceptionally wide knowledge of the markets of the country, DESIRES to NEGOTIATE NEW APPOINTMENT.—Write, Z. M. 613, c/o Deacon's, Leadenhall-st., E.C. 7996 B

CAN ANY ENGINEER HELP?—ADVERTISER (32), B.Sc., A.M.I.E.E., married, 11 years' practical experience, constructional and maintenance, used to big jobs, will ACCEPT any reasonable OFFER. Position serious.—Address, P5252, The Engineer Office. P5252 B

ENGINEER, Thoroughly Experienced in all Kinds of steam and electrical machinery, filled position as chief engineer for several years in large factory, SEEKS responsible POSITION, home or abroad.—Address, P5264, The Engineer Office. P5264 B

MANAGER of 16 Years' Experience, with Public school and technical training, M.I.A.E., A.M.I.M.E., A.M.I.E.E., good disciplinarian and salesman with good connection, sound knowledge of marine, motor, and hydraulic engineering, chemistry, &c., secretarial work, office and works management, highest references and testimonials, SEEKS POSITION as Manager or Representative, in or near London preferred.—W. F. D., Lensdene, Hanwell, W. 7. P5259 B

SITUATIONS WANTED (continued)

MECHANICAL ENGINEER (28), Articled, Sound technical training, 4 years' experience of works organisation and management, 6 years designer and chief draughtsman, shortly disengaged, REQUIRES responsible POSITION in progressive firm. Willing to invest moderate capital.—Address, P5102, The Engineer Office. P5102 B

MECHANICAL ENGINEER, Late Manager of Small works, SEEKS any responsible POST, where 30 years' good all-round general experience (works and office) is of value.—SNOAD, 36, York-road, Hitchin. P5250 B

MECHANICAL ENGINEER, Single, 25, Three years' experience, turbines, reciprocating engines, boilers (W.T. and F.T.), erection, installation, and running same, sea experience; two years' university course and engineering degree; good draughtsman; fluent French; home or abroad.—Address, P5270, The Engineer Office. P5270 B

MECHANICAL ENGINEER WANTS BERTH. Good all-round technical and commercial experience, 15 years in administrative positions in Britain, Continent, America and Africa, and special experience of centrifugal pumping plant. Excellent pre-war, war (R.N.V.R.), and post-war record. Full particulars on application.—R. W. OSTELL PROSSER, 7, Willoughby-road, N.W. 3. P5261 B

PRODUCTION ENGINEER, 18 Years' Experience, all departments, SEEKS POST, any capacity. Was engineer efficiency expert of large plant in U.S.A. —Address, P5249, The Engineer Office. P5249 B

TO ENGINEERS AND CONTRACTORS.—ADVERTISER is OPEN to INSPECT WORK going through fitting and machine shops; 24 years' shop experience.—Address, P5272, The Engineer Office. P5272 B

A CAPABLE DRAUGHTSMAN REQUIRES a SITUATION. Experience; 10 years rail carriage, motor car and aircraft machine detail design; 4 years mech. and general engineering, specialisation work, detail and design, &c. Moderate terms.—Address, P5263, The Engineer Office. P5263 B

DRAUGHTSMAN, Fully Qualified, REQUIRES POST. Experienced in locomotives, ships' deck machinery, motor vehicles, internal combustion engines, ordnance, &c.; useful on new design.—NEILSON, 9, Marsden-street, Barrow-in-Furness. P5262 B

DRAUGHTSMAN SEEKS APPOINTMENT; Works and D.O. experience, heating and ventilating fans and mechanical draught; schemes, estimates, correspondence.—Address, P5265, The Engineer Office. P5265 B

DRAUGHTSMAN (26), Appreciated with Leading engineering firm, D.O. and shops, varied experience, SEEKS ENGAGEMENT.—Address, P5260, The Engineer Office. P5260 B

DRAUGHTSMAN (25), 4 Years' Workshop, 2½ Years' sea-going, 3 years' D.O. experience, design and details, steam and electric plant, conveyors, structural work, &c. Thorough technical training, hard worker; small commencing salary.—Address, P5255, The Engineer Office. P5255 B

JUNIOR DRAUGHTSMAN (21); Five Years' Workshop and drawing-office experience; good ref.; I.C.S.—Address, P5266, The Engineer Office. P5266 B

JUNIOR DRAUGHTSMAN (24), Single, REQUIRES SITUATION with engineering firm immediately, any district. Three years' technical, 2½ years shops, and 12 months' drawing-office experience. No commencing salary necessary; enthusiastic and ambitious.—Address, P5251, The Engineer Office. P5251 B

MECHANICAL DRAUGHTSMAN, with Wide Experience in the design and lay-out of various industrial plants, power station design, and general engineering, DESIRES SITUATION; London or South Coast.—Address, P5256, The Engineer Office. P5256 B

FOREMAN BOILERMAKER, Disengaged, Non-union man, SEEKS POSITION as Foreman on Locomotive or Stationary Boilers or General Work; 15 years' experience as head foreman, home and abroad; total abstainer; good references.—Address, P5271, The Engineer Office. P5271 B

BLACKSMITH, Good All-round, Iron or Steel Hand forgings and repairs; 18 years' wide experience; any district; non-union.—POYNER, Coton-in-the-Elms, Burton-on-Trent. P5267 B

PARTNERSHIPS

ENGINEERING PARTNERSHIPS AND BUSINESSES.

Wheatley Kirk, Price & Co.

46, Watling Street, London, E.C. 4.

Established seventy years.

AGENCIES

AGENTS WANTED by Belgian Engineering Firm, for Sale in England and Colonies and in Ireland of first-class Pumps and Compressors. Preference to French-speaking engineers.

Apply, with references, to ATELIERS DE CONSTRUCTION D'ENSIVAL SOCIETE ANONYME, Wegnes par Pepinster (Belgium). 7914 D

PATENTS

THE PROPRIETOR of BRITISH PATENT No. 9138/15, dated June 22, 1915, relating to "Improvements in Toothed Gearing," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Ill. 7961 H

THE PROPRIETOR of BRITISH PATENTS Nos. 127,824, 138,619 (Div. Appl'n.), and 127,825, all dated June 1, 1918, relating to "Improvements in Processes for Bonding or Uniting Articles, particularly the Parts of Vacuum Insulated Vessels," "A Vacuum Insulated Vessel," and "A Process for Producing Indurated Compounds from Lac or its Derivatives," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patents and ensuring their practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Ill. 7997 H

THE PROPRIETOR of BRITISH PATENT No. 6402/13, for "Process and Apparatus for Pressing Plates and Layers, or Sheets of Fibrous Agglomerated Materials," DESIRES to INTRODUCE his INVENTION to the notice of manufacturers and others with a view to the invention being worked commercially under LICENCE or otherwise.—All communications to be addressed to Messrs. JENSEN and SON, Chartered Patent Agents, 77, Chancery-lane, London, W.C. 2. 8015 H

EDUCATIONAL

ARTICLED PUPIL.—A CIVIL ENGINEER Has a VACANCY for well-educated young gentleman as PUPIL; good practical and theoretical training; interesting works in hand; premium required.—Address, 7995, The Engineer Office. 7995 E

CORRESPONDENCE COURSES for Inst. C.E., Inst. Mech. E., London Univ. (Matric., Inter., and B.Sc.) personally conducted by Mr. TREVOR W. PHILLIPS, B.Sc. (Honours), Assoc. M. Inst. C.E., M.R.S.I., F.R.S.A., &c. Also Day Tuition in Office. Excellent results at all Exams. Courses may commence at any time.—8/11, Trafford Chambers, 58, South John-street, LIVERPOOL. Ex.

INST. C.E. Inst. Mech. E., B.Sc., and all ENGINEERING EXAMINATIONS.—Mr. G. P. KNOWLES, M.B.E., B.Sc., A.M. Inst. C.E., &c., personally PREPARES CANDIDATES, either orally or by correspondence. Thousands of successes during the past sixteen years. Courses can be commenced at any time.—39, Victoria-street, Westminster, S.W. Telephone No., Victoria 4780 Ex.

LEARN SURVEYING AND LEVELLING.—Thorough practical instruction given by an expert.—Address, E. MOUL (late L.S.W. and S.P.D. Rlys.), Hollybank, Woking. P5210 E

MISCELLANEOUS

A LARGE FIRM of MECHANICAL ENGINEERS, with excellent plant and manufacturing facilities, including well-equipped foundry, are PREPARED to BUILD immediately any type of MACHINE or COMPONENT which is required in quantities.

Advertisers have had 30 years' experience in the production of high-class work in units up to 6 tons weight, and can cope with large contracts.

Address, 7988, The Engineer Office. 7988 I

DESIGN (Drawings, Specification and Estimate) for simply supported through girder Road Bridge, 150ft. span, is FOR SALE; artistic, unbuilt.—Address, P5253, The Engineer Office. P5253 I

DRAWINGS and TRACINGS PREPARED by Experienced Engineering Draughtsmen; prompt attention and moderate charges.—Write, SHERRIFF and CO., 1, Salisbury-gardens, Chingford, E. 4. P5268 I

HIGH-GRADE WHITE METAL SCRAP, TURNINGS, RESIDUES.—WANTED by actual users, constant SUPPLIES of the above, with as high tin contents as possible. High prices paid for suitable material. Also Common Tin, such as Bolivian, Peruvian, &c.—Address, 8016, The Engineer Office. 8016 I

PATENTS, INVENTIONS, TRADE MARKS DESIGNS. Advice and handbook free.—KING'S PATENT AGENCY, Limited (B. T. King, Director) 146a, Queen Victoria-street London. 35 years' refs. Tel., Central 682. 7939 I

THE TECHNICAL REPRESENTATIVE of JOHN MASSEY and CO., Ltd., of Johannesburg, with branches throughout the South African Union, is in London and will be pleased to ADVISE MERCHANTS and MANUFACTURERS of Engineering Plant and Machinery, Small Tools and Electrical and Mechanical Appliances of every description as to the great opportunities for Export Trade to South Africa.—Write to Mr. ROBERT ASHBURNER, c/o Messrs. Lacey, Johnson and Co., Engineers, 83, Victoria-street, London, W. P5244 I

MACHINERY, &c., WANTED

WANTED, a COUPLE of First-class Second-hand Double RAILWAY WAGON WHEEL TURNING LATHES; also 24 PAIRS Main Line WAGON WHEELS, 6ft. 4in. centres, 7in. journals, thick tyres.—Address price, particulars, and where to be seen, 8001, The Engineer Office. 8001 F

WANTED, CRUSHER, New or Second-hand, Suitable for breaking iron or copper pyrites; size not less than 16 by 9 jaw opening.—Address, 8004, The Engineer Office. 8004 F

WANTED, HYDRAULIC PRESS, in Good Condition, suitable for flanging ends up to 8ft. diameter by 7-8in. thick, including vertical boiler crowns.—Address, 7992, The Engineer Office. 7992 F

WANTED, TWO LOCOS. and THIRTY Wood end-side TIPPING WAGONS, 1½ to 2 yards capacity, 3ft. gauge; 12in./13in. LOCO., 4-wheel, 4ft. 8½in. gauge. All really first class. Give fullest description, prices, &c.—Address, 8005, The Engineer Office. 8005 F

WANTED, UPSETTING and FORGING MACHINE, preferably "Ajax" type, size 4in. or 5in.; must be in good condition. State price and where can be seen.—Address, 7947, The Engineer Office. 7947 F

SECOND-HAND "KEARNS" No. 3 SURFACING and BORING MACHINE or similar machine WANTED; good condition essential.—Address, 7991, The Engineer Office. 7991 F

FOR SALE

A TIME RECORDER, as New, Guaranteed, Latest model. What offers?—A, F. PELLEY, 149, Farrington-road, E.C. 1. Ex.

BOILERS FOR SALE.

ONE Lancashire, 28ft. by 7ft. 2in., for 100 lb. pressure.
One Cornish, 20ft. by 6ft., for 100 lb. pressure.
One Cochran Vertical, 14ft. by 6ft. 6in. for 100 lb. pressure.
One Cochran Type 15ft. by 7ft. 6in., for 100 lb. pressure.
One Hindley Tubular, 12ft. by 4ft. 6in., for 100 lb. pressure.
Two Ditto, 11ft. 6in. by 4ft., for 160 lb. pressure.
One Cochran, 10ft. by 4ft. 6in., for 90 lb. pressure.
One Vertical Tubular, 7ft. 6in. by 3ft. 3in., for 160 lb. pressure.
One Vertical Tubular, 16ft. by 4ft., for 70 lb. pressure.
One Vertical Cross Tube, 10ft. by 4ft., for 80 lb. pressure.
One Vertical Cross Tube, 8ft. by 3ft., for 60 lb. pressure.
Two Ditto, 6ft. by 2ft. 3in., for 80 lb. pressure.
Six Ditto, 4ft. 6in. by 2ft. 11in., for 80 lb. pressure (new).
One 40 H.P. Loco. Type, 160 lb. pressure.
Two 14 H.P. Loco. Type, 150 lb. pressure.
One 10 H.P. Loco. Type, 100 lb. pressure.
One 12 H.P. Loco. Type, 80 lb. pressure.
GEO. COHEN SONS and CO., 600, Commercial-road East, London, E. 14. Ex.

BOILERS FOR SALE.—TWO Second-hand LANCASHIRE BOILERS, 30ft. by 8ft., by Adamson, Dukinfield.—Can be seen by appointment, SUN FLOUR MILLS COMPANY, Bromley-by-Bow, London, E. 3. 7878 G

BRINELL TESTING MACHINE, by Derihon, 3000 kilogrammes deadweight type. Illustration and full details upon application.—JONES, 18/20, Churchstreet, Islington, N. 1. P5184 G

CORLISS HORIZONTAL ENGINE, About 200 I.H.P., 100 lb. working pressure; also 28ft. by 6ft. 6in. LANCASHIRE BOILER, as new, and mountings; complete installation or divide; very cheap to save second moving.—A. DODMAN and CO., Ltd., King's Lynn. 7958 G

DIESEL ENGINES, Six-cylinder, Two and Four-stroke, 850, 1000, 1200 H.P. Excellent condition. DYNAMOS for above, 250 or 500 volts D.C. Immediate delivery and low price.

Also TWO 500 K.W. PARSONS TURBINE SETS, 250 or 500 volts D.C., with condenser and spare armature.

ELECTRICALLY DRIVEN AIR COMPRESSORS, 250 volts D.C., pressures 1500 to 2000 lb. per sq. inch. JENNINGS West Walls, Newcastle-on-Tyne. Ex.

FOR SALE

ENGINE FOR SALE.—500 H.P. Tandem Compound Condensing STEAM ENGINE, by Pollitt and Wigzell, Bowerby Bridge, fitted with Corliss, H.P. cylinder, slide valves, L.P. jet condenser, 16ft. flywheel grooved for fifteen 1¼in. ropes; in good order and is being displaced by electric power. Also TWO WIRE PUMPS.—Above can be seen by appointment, SUN FLOUR MILLS COMPANY, Bromley-by-Bow, London, E. 3. 7975 G

ENGINE INDICATORS, Steam and Explosive Types, Dobbie McInnes, new, at half price; used; third maker's price.—SUN LANE WORKS, Blackheath, S.E. 3. 7990 G

FOR SALE, Brand New "Priestman" CRANE GRAB DREDGER, for mounting on large or pontoon; 10-ton type crane, jib about 30ft., Capacity of grab 45 cubic feet. Packed ready for shipment. Bargain price to clear.—R. H. NEAL and CO., Plant Engineers, 53, The Broadway, Ealing, London, W. 7. 8010 G

FOR SALE.—Cochran BOILER, 14ft. by 6ft., passed for 80 lb. working pressure.
Also Two-throw 6in. Ram DEEP-WELL PUMP.—GRIMSBLEY and CO., Ltd., Queen-street, Leicester. 7928 G

FOR SALE.—Dismantling of Refining Plant.—FOR DISPOSAL, ENGINES, EXTRACTORS, OIL PRESSORS, BLOWERS, STEEL and C.I. TANKS, SHAFTING, &c.—Address, 7981, The Engineer Office. 7981 G

FOR SALE, Extra Heavy Type PLUMMER BLOCKS, second-hand, but in serviceable condition; 20, 4¼in.; 27, 4in.; 18, 3½in.; 3, 3in.; at practically scrap price.—BRIMSDOWN LEAD CO., Ltd., Brimsdown, Middlesex. 7064 G

FOR SALE, First Quality SECOND-HAND SLEEPERS; main line, uncreosoted; good for sidings, east roads, &c.—R. H. NEAL and CO., 53, The Broadway, Ealing, W. 7. Telephone, Ealing 1784. 7851 G

FOR SALE, RAILWAY TANK WAGONS, Built 1921, capacity 14 tons, specially equipped, including internal heating coils.—Plans, specifications, &c., can be obtained on application to CAMPBELL JAMES and COMPANY, Ltd., 18, Hopemaker-street, E.C. 2. P5269 G

FOR SALE, THEODOLITES,
DRAWING INSTRUMENTS, SECOND-HAND.
CLARKSON'S, 338, High Holborn, W.C.
(Opposite Gray's Inn-road).

FOR SALE, LEVELS,
DRAWING INSTRUMENTS, SECOND-HAND.
CLARKSON'S, 338, High Holborn, W.C.
(Opposite Gray's Inn-road). Ex.

FOR SALE.—TWO SETS of Inverted, Direct-acting, Compound, Surface Condensing MARINE ENGINES (single screw), cylinders 17in. and 34in. by 24in. stroke, 190 lb. per square inch w.p., complete with condensers, main and auxiliary pumps and fittings, thrust shafts and blocks, tail shafts with keys and nuts, together with miscellaneous fittings, spare gear, &c.

Also FOUR BOILERS (two for each set of engines), 9ft. 6in. ext. dia. by 9ft. ext. length, 150 lb. per square inch w.p., Lloyd's survey, total H.S. 1486 square feet, total G.A. 58 square feet, complete with usual mountings, furnace fittings, fire-bars, &c.

TWO SMOKE-BOXES and ONE FUNNEL, complete.

PLATES for Second FUNNEL ready for building.

For specification, complete list and particulars apply to FORTH SHIPBUILDING and ENGINEERING CO. (1921), Ltd., Alloa. 7909 G

FOR SALE.—10-TON OVERHEAD HAND CRANE, span 28ft. 8in., practically new; price £70 delivered U.K.

Also RUNNING TRACK, 150ft. long, for £140. Special quotation for shorter length.

Apply, J. and P. ZAMMIT, Contractors, Llanelly. 7962 G

FOR SALE.—
90 TONS of 15in. C.I. FLANGED PIPES, drilled to B.S.T. No. 2, lengths from 3ft. to 12ft.
14 TONS of 6in. C.I. FLANGED PIPES, drilled to B.S.T. No. 2, 9ft. and 6ft. lengths.
50 N.H.P. LOCO. TYPE BOILER, by Davy, Paxman, re-insure 150 lb. pressure.
10ft. 9in. by 4ft. 6in. Spencer-Hopwood Paint VERTICAL BOILER, re-insure 100 lb. pressure.
STANLEY ENGINEERING CO., Bath. Ex.

FOR SALE,
2 40-TON
STEAM TITAN CRANES,
BY
STOTHERT & PITT, LTD., BATH.

Capacity, 40 tons at 50ft. radius and 14 tons at 100ft. radius. Gauge 24ft. Wheel-base 24ft.

One crane erected in this country and one crane dismantled abroad, ready for shipment. Both cranes in excellent condition.—Apply:

S. PEARSON AND SON
(Contracting Department), Limited,
16, Victoria-street, Westminster, S.W. 1. 7947 G

GOVERNMENT STORES AT SLUMP PRICES.—Bisek Corrugated Sheets, 6ft. and 7ft. lengths, 2s. per sheet.

500 Tons Granite Setts.	600 Tons Hard Core.
English Oak and Elm Logs cut into Planks.	
Decsuville Railway.	Foden Steam Wagons.
Dar Steel.	Trailers.
	Motor Wagons.

Government Huts of all sizes.

Girders.	Bolts.
Roof Trusses, 90ft. span.	Nuts.
Angle Iron.	Nails.
Stanchions.	Every description of
Expanded Metal.	Building Material.
Roofing Felt.	Electrical Lighting.
Generating Sets.	

Apply, PHILLIPS, MILLS and CO., Ltd., Brides Wharf, Battersea, S.W. 11. 7834 G

MAGNIFICENT 700 I.H.P. HORIZONTAL CORLISS VALVE CONDENSING STEAM ENGINE, by Hick-Hargreaves, rope fly-wheel, jet condenser; new 1911.—Full details, HARRY H. GARDAM and CO., Ltd., Staines. 7859 G

NEARLY NEW MULTI-CYL. INDUSTRIAL TYPE 450 H.P. NATIONAL GAS ENGINE, new about 1917. 300 revs. Bargain.—HARRY H. GARDAM and Co., Ltd., Staines. 7841 G

NEARLY NEW 200 K.W. Bellias-Siemens STEAM GENERATING SET, comprising Engine (over 5000) coupled to Multipolar Dynamo of the latest pattern, 105 volts, 1905 amps. Could be conveniently re-wound to 220 or 440 volts. Tempting price.—HARRY H. GARDAM and CO., Limited, Staines. 7851 G

ONE New HYDRAULIC BALING PRESS, Capacity 200 tons, with three rams 24in. and 9in. diar. by 16ft. 6in. stroke; fixed box, 3ft. 4in. by 1ft. 4in. by 12ft.; working pressure 2½ tons per square inch; including ONE Horizontal Belt-driven Double-cylinder PUMP with four plungers, mounted on a cast iron bed-plate, pump barrels and plungers of gun-metal, 15-16in. diar. by 12in. stroke, fast and loose belt pulleys, suitable for compressing wool, cotton, fibre, coir, esparto, &c. Low price to clear.—Inquiries to the Liquidator, SCOTTISH MESOPOTAMIA CORPORATION, Ltd., 31, George-street, Edinburgh. 7986 G

For continuation of For Sale Advertisements, see page iii.

Chinese Engineering Notes.

(*From our own Correspondents.*)

Peking.

I HAVE just returned from a three weeks' tour in Manchuria, during which I have been astonished at the lack of British enterprise in that territory. Not a single British engineering firm is represented in Mukden, the seat of the Government of the Provinces of Manchuria, Kirin and Heilungkiang. There is a very large demand in all these three provinces for electrical equipment, mining equipment, machine-shop equipment, tool steels, &c. &c., and practically all orders for these materials go to America. The American manufacturer is fairly well represented in Mukden, Kirin, Harbin and Tsitsihar. The Tuchun (Military Governor) of Manchuria is also Inspector-General of the three Provinces, and his personal adviser is the late American Consul-General in Mukden. It is unfortunate that a number of British firms look upon Manchuria as being absolutely under Japanese control and influence, and do not consider it worth while to seek for business in that territory. All supplies for the South Manchurian Railway naturally pass through the Japanese merchants, but apart from that fact there is ample scope for British enterprise. The arsenal contract referred to in a recent letter was concluded between the Manchurian Government officials and the Nielsen and Winther Engineering Company, Limited, a Danish company. The Danish Government was a party to the "Arms Embargo Agreement," and in spite of protests from the British, American, Japanese and Italian Legations in Peking the contract is to be carried through and orders to the extent of £1,000,000 are to be placed. It is an open secret here that most of the equipment is to come from Germany.

General Chang Tso Ling, the Military Governor of Manchuria, and Inspector-General of the three Eastern Provinces, stands out to-day as the most powerful man in China, and it is an undoubted fact that his territory is well governed and prosperous. General Chang is very anxious to encourage foreign enterprise, and is particularly interested in the construction of roads, the opening of mines, and the development of the grain industry. These enterprises call for large supplies of machinery, and it is to be hoped that the British manufacturer will get his share. But to do so he must go and get the business. It will never be sent to his agent or office in Shanghai or Tientsin.

The Wah Shing Trading Company—a Sino-American company—has recently obtained the contract for the Harbin tramways. It is understood that this company has obtained the concession for running the tramways for a period of years, and will supply the whole of the equipment in consideration of contributing a portion of the required capital. The equipment will come from America.

The Mukden Electric Light Company will shortly place an order for a turbo-electric set of 1000 kilowatts and accessories in connection with the extension of its present plant.

Shanghai.

The Chinese are becoming very averse to any foreign enterprise being carried out entirely by foreign capital, and it would be practically impossible in these days for foreign enterprise to build a railway or establish a public utility concern anywhere outside a concession unless Chinese capital were involved in the undertaking. This would seem to imply a "dog in the manger" attitude, but it is only so this far, that no Chinese Government or provincial authority is in a position to ask for capital with which to promote a public utility undertaking or build a railway, as practically all the official revenue of the country is mortgaged up to the hilt. But this state of affairs is far from representing the financial potentiality of the nation. There is immense wealth in the hands of the Chinese, and many of them are eager to employ that wealth in promoting industrial development, but they are afraid to do so of their own initiative, because indication of wealth in China is sure to be followed by extortion by rapacious relatives and officials. A Chinese who gets rich, gets rich quietly, or as a member of a protective combine, or, better still, as a member of a foreign firm. For instance, the Chinese own about two-thirds of the 36 million pounds' worth of land in the International Settlement of Shanghai, but all that land is officially registered in the name of foreigners, mostly British. You cannot call land a liquid asset, but it is nearly so in Shanghai, as it is mostly mortgaged and the proceeds used in various ways. It follows that we have a potential Chinese wealth from land alone of about £24,000,000 in the Shanghai International Settlement, without counting the French Settlement and the surrounding native districts, the two of which would more than double the total wealth. The land value in Shanghai is increasing at the rate of at least 10 per cent. per annum, so the security is good.

There are many development schemes already outlined, such as railways, wharves, docks, hydro-electric works, waterworks, reclamation works, tunnels, elevated railways, subways, tramways, &c. &c., which have been deferred owing to either lack of a definite policy by an impecunious Government or because of the difficulty of combining Chinese and foreign money, which, as has been said, is essential to success. But there are signs of this object being attained through the mediation of Chinese and foreign banks, and it appears to be possible to get Chinese wealth into sound and lucrative channels by their combined assistance.

British manufacturers and financiers should therefore aim at obtaining a practical industrial development scheme such as those mentioned, and promote the undertaking through the native and foreign banks. In this way the Chinese and foreigners obtain mutual financial security, and the way is opened for the foreign manufacturer to sell the necessary machinery and other requirements which China cannot herself produce at present.

There will be no difficulty with whatever Chinese Government is in power at the time, as whatever may be said about a Chinese Government's ability to develop the country's needs or keep the exchequer out of the control of grasping officials, it cannot be denied that to save "face" the Chinese Government has always accorded facilities to a combination of native and foreign interests, whether from a sense of respect for the foreign legation concerned or from a sense of opportunism cannot be said, but anyhow it is sure that given a true and unmonopolistic combination of Chinese and foreign interests the Chinese Government is all for the spending of money, and in this is in line with all Governments—the result being left to the sound common sense of the people.

Hong Kong.

The British in China have just emerged from a crisis graver than any that can be found in the history of foreign trade in the Far East. It was caused by a strike of Chinese seamen. It meant, in the end, a definite challenge by labour to the whole of the community of the colony of Hong Kong.

It is vaguely known in Great Britain that there are millions of manual workers in China. The economic condition of the huge country is not generally understood. In the minds of many educated people China is still a land where the men wear pigtails and British missionaries are saving the girl babies from destruction. In actual fact, you cannot find a pigtail in South China to-day; and the writer, after many years of residence in China, has not discovered a case of infanticide. In view of this strike, it may be of interest to glance at some of the recent changes that have taken place in China which may be said to have been directly or indirectly caused by the engineer. There is, first of all, the effect of the engineering work done in the colony of Hong Kong. There are about half a million Chinese who live in a place where there are admirable roads, motor cars, electric trams, a railway, telephones, a splendid water supply, and three large dockyards. There are also cement works, sugar refineries, cold storage rooms, rope works, paper mills and other factories.

Within a hundred miles is Canton, the largest city in China. Numerous steamers run regular services between Hong Kong and Canton, and there is now the railway. Canton may be considered as by far the most important city in South China; with the possible exceptions of Hankow and Shanghai, it is the city with the greatest industrial future in the whole of China. Hong Kong is, in reality, the port of Canton and of the two Kwang provinces. Kwang-tung has a population of about 30,000,000 people, and Kwangsi a population of about 22,000,000.

A few years ago it was the custom in Hong Kong to regard labour conditions as fixed. A Chinese labourer, or as we say, a "coolie," was paid about fifteen shillings a month in Hong Kong and about ten or twelve shillings a month in Canton. He could get rice for food twice a day, and he seemed to require but little else. Then machinery was introduced, and it demanded rather more than just muscular power. To-day, we pay the coolie who carries a sedan chair ten dollars a month, but a chauffeur obtains fifty dollars a month. The Chinese chauffeur is certainly doing work requiring more intelligence than a chair coolie, for the latter is, in reality, simply being used as a beast of burden.

A mechanic in Hong Kong now receives about forty dollars a month—say just about a pound a week when the exchange is at a normal value of two shillings. About two years ago the Chinese mechanics organised a successful strike, which secured them a considerable increase in wages. It also demonstrated that labour in China could unite. It was inevitable that, after the rise in wages of the mechanics, the other classes of skilled labour should seek for a readjustment of wages.

The Chinese seamen declared a strike because of two main grievances. One was the common excuse for almost any strike, viz., that the demand for an increase in wages was not granted. The other grievance was that the wages were paid by the shipowner to a Chinese stevedore who made deductions. We wish to emphasise the entirely new condition in China. It is that labour has been able to organise itself in a way that no other section of the Chinese community has previously organised itself. There can be no doubt whatever that the Chinese seamen finally succeeded in either causing or persuading every other section of Chinese labour in the colony of Hong Kong to cease work. The house servants, even including the Chinese women who act as nurses; the chair coolies, the butchers, bakers, mechanics—everyone went on strike, with the exception of a few sanitary coolies whose absence might have led to a disastrous epidemic.

More Machinery Needed.—The first demand of the local employers in Hong Kong, now that the strike is over, is for more machinery. There were, for seven weeks, about one hundred and fifty ships lying in the harbour of this colony. They could not be loaded or unloaded, simply because, for all practical purposes, the work could not be done without coolie labour. The cargo ship has in the past in most cases discharged on to a junk; the junk has been unloaded by hand labour at the wharf, and the goods have then been carried on the backs of coolies to the "go-downs," or store-rooms. The demand now is that machinery must be employed where possible to replace man-power.

Sir Maurice Fitz-Maurice visited Hong Kong at the request of the local Government, and is reporting concerning port facilities. It seems inevitable that he will recommend some system so that cargoes of rice shall not again remain on ships in the harbour while rice is in great demand ashore.

It must be remembered that during the years 1918–19 Hong Kong and Shanghai experienced phenomenal prosperity. There was a great demand for labour, and it is at such times that there are demands for increased wages, as the cost of living invariably increases. There seems to be no need for Great Britain to regard with any anxiety an increase in the wages paid to Chinese workmen. The country of China can afford to supply the increase if only the natural resources are properly developed. Any increase in the standard of living in any part of Asia leads to an increase in the demand for goods from Europe or America. Any effort to increase the natural resources of Asia leads also to a demand for machinery from Europe or America.

There are those in Great Britain who try to make our flesh creep by suggestions about cheap production in the near future by the Chinese capitalists, because of cheap labour. It cannot happen in this generation. The always present problems in China are those which the engineer must settle—to regulate the rivers so as to prevent floods, to increase the food supply, and to improve the means of communication. There are also the mines to be developed, but if the Government and the capitalists of China were properly organised, there is sufficient engineering work in the country to be done during the next four or five decades to absorb the output of the mines and to need much machinery from abroad. In return, China can send vegetable products, such as tea, oils, &c., and also silk, to Europe.

Finally, let there be no mistake about the Chinese national character. Above all else, the Chinese are peaceable. At present the great need in China is a leader such as "Chinese Gordon" proved himself to be. If anyone, foreigner or Chinese, could successfully direct the energies of the Chinese people in the direction of developing the natural resources of their own country he would do an immense service to humanity. It is part of the creed of the engineer who has any belief in the nobility of his work that his object is gradually to raise the standard of living of all races by utilising the forces of Nature for the use and convenience of man. The engineer who is true to that creed has no finer field for his energies than in China.

The German Submarine Building Programme, 1914-1918.

A CONSIDERABLE amount of information has been published on the subject of the U-boat warfare and its effect on the war as a whole. Also detailed descriptions of the various types of submarines used, based on examination of those surrendered have been given, notably in a paper by A. W. Johns, C.B.E., R.C.N.C., before the Institution of Naval Architects. The subject of the actual building programme and the results obtained as the war progressed is of considerable interest technically.

The Germans were late in developing the submarine, following well behind the French and ourselves. The type of boat favoured was the double-hulled type (French Laboeuf type, with slight modifications to the shape of the tanks) rather than the single-hulled Holland boat first used by the British Navy. In the development of the submarine, as in much other work of a similar experimental nature, the firm of Krupp's played an important part. The first U boats were built at the Germania Yard (owned by Krupp's) on Kiel Bay. The only other shipyard building them, up to the war, was the Imperial Shipyard at Dantzic. At these two shipyards twenty-six submarines had been built before the outbreak of war, viz., U 1 to U 25 and U 28; U 26 and U 27 were completed very soon afterwards. Of these submarines, U 1 to U 4, being obsolete, were out of commission. Up to February, 1915, the losses practically balanced the output from the two building yards referred to. It has been stated that by this date U 26, U 27, and U 29 to U 37 had been built, but seven U boats, viz., U 5, U 7, U 11, U 13, U 15, U 18 and U 26, were lost on service.

Fig. 1 is interesting, showing, as it does, the sub-

marines under construction at Krupp's Germania Yard, Kiel, in August, 1914. It will be seen that special wharves are provided for the submarines to lie alongside when "fitting out." The big merchantman on the right of the picture is the motor ship Zoppot, built and engined by Krupp's. She was begun in 1913, but was not complete until 1919. Detailed figures of the output of submarines from Germania Yard will be given later.

As soon as the war broke out the U-boat commanders made claims for these vessels which the High Sea Fleet would not accept. In October, 1914, however, impracticable. The building in the German shipyards took one hundred days for the quickest boat, and the whole seventeen were completed by May, 1915. The actual operation of re-erecting in the distant yard is said to have taken ten days only, but this time is likely to have been exceeded, bearing in mind the very delicate nature of the job. Both at Pola and at Hoboken many skilled German workmen were employed under the direction of German experts. When the Austrian yard was in full operation some 2000 skilled Germans were employed there, and it is stated they were very dissatisfied with the equipment.

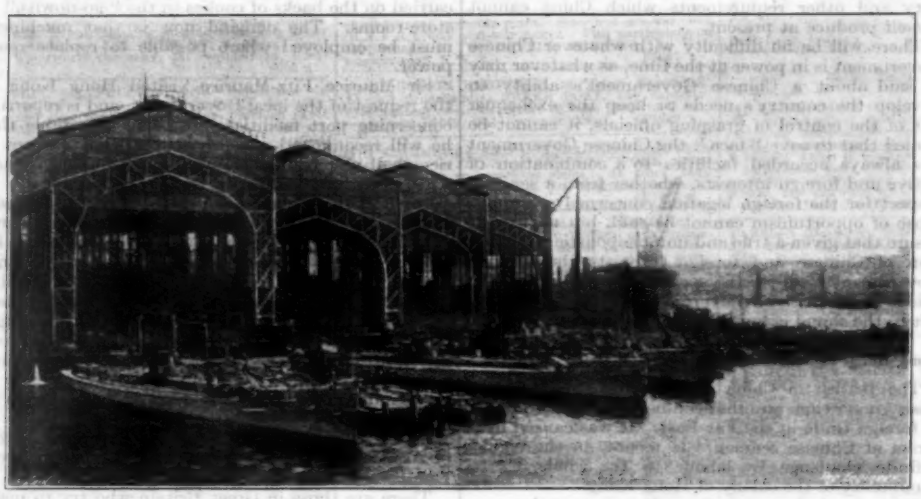


FIG. 1—SUBMARINES IN HAND AT GERMANIA WERFT, KIEL, AUGUST, 1914

it was decided to order a number of the smaller type of U boats for coast and harbour defence duties. With this decision it became necessary to utilise other shipyards for the production of U boats. Accordingly, UB 1 to UB 15 were ordered in October, 1914, and UB 16 and UB 17 were ordered a month later. The two yards involved were Germania Yard, Kiel, and A. G. Weser Shipyard, Bremen. These boats were built in sections, so that they could be transported overland and put together at Pola for service in the Mediterranean, and at Hoboken Yard, Antwerp, for service off the Flanders coast. The maximum

FIG. 2—THE MERCANTILE SUBMARINE DEUTSCHLAND

diameter of the pressure hull was 3.15 m. The hull was built in three pieces, which were afterwards connected together by strong bolted flanges. The whole of one submarine could be taken in one train. Special trucks took the separate sections of the hull. The conning tower, with its brackets, &c., was placed on another truck, the engines on another, whilst the batteries and equipment with the necessary supervisors were taken on the remaining trucks or carriages. In addition to using the Austrian dockyard at Pola, it was also hoped to be able to put these small U boats together at Constantinople, but that course was

This small type of U boat had only one engine of 60 horse-power with a very limited radius. Some boats, however, made the journey from Cattaro to Constantinople under their own power. As the war lengthened out more ambitious schemes were afoot and larger boats were needed.

At the same time as the "UB 1–17" class were ordered for coast defence demands were made for a small minelaying submarine. Accordingly, soon after the war opened the small UC boats of 168 tons displacement were started. They also were built in sections so as to be transportable by rail. Another shipyard new to submarine work was employed on UC 1 to UC 15, viz., the well-known Vulkan Yard at Hamburg.

When the "UB 1 to UB 17" class was found to be too small, orders were placed for the larger boats of UB II. type. These comprised UB 18 to UB 47, which were ordered in September, 1915. Blohm and Voss, Hamburg, built eighteen and A. G. Weser, at Bremen, built the other twelve. These boats had two engines, with greater endurance both on the surface and when submerged. The size of the torpedo tube was also increased. The first German submarine to circumnavigate Great Britain was of this type. As the diameter had increased to 3.85 m. it was not easy to arrange for their transport overland, and, apart from six of those ordered from A. G. Weser, which were fitted together on the slips and then sent to Pola for re-erection, the whole of this class of submarine was finished in the German shipyards. The time taken to build these thirty boats varied from six to ten months each.

With the institution of the U-boat blockade still bigger submarines were required, and the largest "UB" type, known as UB III. was designed. One hundred and two of this class, UB 48 to UB 149, were ordered in May, 1916. They were expected to get 13.5 knots, so as to be able to overtake readily the average merchantman. The torpedo tube armament comprised four bow tubes and one stern tube. These submarines were too large to build in sections, and incidentally all of them were not completed before the Armistice. The details as to building yards, boats not completed, &c., are given in tabular statement A. As with the "UB" type, so a larger "UC" type was ordered early in 1915. These boats, UC 16 to UC 79, were all completed before November, 1918, together with UC 90 to UC 105 of a later order.

Apart from the two types mentioned, the Germans built the so-called "straight" "U" type of boat for ordinary fleet work. When war broke out U 29 to U 41 were in hand at Kiel and Dantzic, and immediately afterwards U 43 to U 65 were ordered. U 42, building at the Fiat Works at Spezzia was taken over by Italy. These submarines were distributed over the building yards, as shown in the tabluar statement A.

When the U-boat blockade was instituted in February, 1915, Germany had under construction UA, U 39 to U 80 (*ex* U 42)—that is, forty-two large boats—and UB 1 to UB 47 and UC 1 to UC 79, making 126 small boats.

Certain submarines were built for special service, particularly the so-called cargo-carrying or mercantile submarine. She was a slow boat, with little armament, the saving in weight being utilised for cargo carrying. The best known of these vessels was the Deutschland, of which two pictures are given. Fig. 2 shows her on the building slip at Krupp's Germania Yard, Kiel. She is being built on one of the large open slipways, which are parallel and to the left of the covered slipways shown on Fig. 1. This slip is served by travelling cranes on an elevated railway carried by the structure on the right of the picture. Fig. 3 shows the same submarine immediately after her launch.

Another special type was the large minelaying submarine, from which the mines were ejected by air pressure through large tubes in the stern. In Table A the gradual development as regards tonnage can be followed.

When the war ended Germany had impressed practically all her shipyards for U boat or destroyer construction. The number of submarines completed by the various establishments during the war, together with the number in hand at the Armistice, is given below.

Shipyard.	Submarines built during the war.	Submarines in hand at Armistice.
Krupp's Germania, Kiel	79	28
Imperial Yard, Dantzic	32	32
Blohm and Voss, Hamburg	67	39
Vulkan, Hamburg	89	37
A. G. Weser, Bremen	74	27
Bremer Vulkan, Vegesack	4	20
Smaller yards	—	41
Totals	345	224

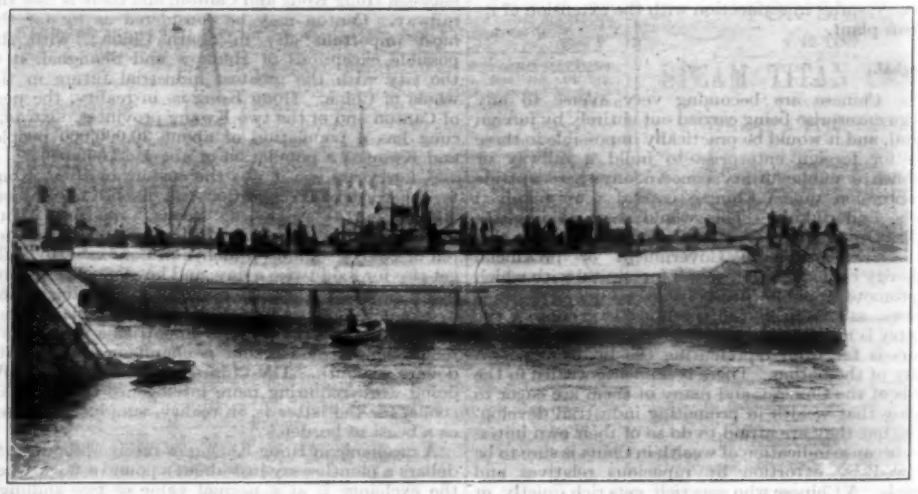


FIG. 3—THE LAUNCH OF THE DEUTSCHLAND

The forty-one boats in hand at the smaller yards were of the small "UF" type, intended for the defence of the Flanders coast. None of this class was completed for service.

As stated previously, twenty-six U boats were built before August, 1914. In addition to those indicated above, some 220 submarines were ordered during 1918, of which only one or two were started. From these figures one can estimate the total U-boat programme :—

Built up to August, 1914	26
Built during the war	345
Being built at end of war	224
Ordered in 1918	220
	815

This total agrees very closely with Admiral von Capelle's statement before the Reichstag Committee, in which he claimed that arrangements had been made

for the building of 810 U boats. Of the 345 built during the war, there were 114 ordinary U boats, 136 of "UB I.," "UB II.," and UB III." types, and 95 of the "UC" class.

As the war lengthened so Germany's output of submarines increased. The number of U boats completed each year, with the corresponding displacement, is given below :—

	Submarines.	Displacement, tons.
Aug. 1st, 1914, to Aug. 1st, 1915	19	16,075
Aug. 1st, 1915, to Aug. 1st, 1916	65	32,959
Aug. 1st, 1916, to Aug. 1st, 1917	101	56,453
Aug. 1st, 1917, to Aug. 1st, 1918	99	68,671

The anticipated output during the year commencing August 1st, 1918, was 167 boats. The 345 noted as built undoubtedly includes a few boats the completion of which took place after the Armistice.

The greatest number of submarines completed in any one year was 110, between January 1st and December 31st, 1916, and of these fifteen were delivered in the last month of the year. Of course, the majority of these submarines were of the moderate sized "UB" and "UC" types ; but, even allowing for this fact, the achievement was a notable one. The output anticipated in 1919 was considerably greater—in fact, twice as many boats were being legislated for—but it is unlikely that these hopes would have been nearly realised.

In the years succeeding 1916 the output was less, consequent upon the increasing size and complexity of the later submarines. It will be seen in tabular statement A that the U boats in hand of the "U 160" class, when war broke out, were smaller than those immediately preceding them. In fact, the building of the very large U boat presented many difficulties. They were not sufficiently stable and much top weight had to be removed ; even then they were reported as being difficult to control in a seaway. Their speed both on the surface and submerged was also less than anticipated. Many authorities considered that the moderate-sized "U 160" class would have met all requirements, and it has been urged that the larger submarines slowed down the output and retarded the development of the U-boat war. In short, it is claimed that if Germany had kept to the moderate-sized boat she might have been successful. In any case the decision to revert to the smaller submarine was arrived at too late to be of any assistance, as Germany was already beaten by the blockade enforced by the Grand Fleet.

The cost of building submarines rose steadily, mainly on account of the continuous increase in the wages paid, which were, in 1918, more than double those ruling in 1914. The cost per ton of surface displacement was 2700 marks early in 1915, and in 1918 5400 marks per ton.

A chart given in Fig. 4, page 434, sets out in graphical form the following particulars :—

(1) The number of submarines ordered at various times between August, 1914, and November, 1918.

(2) The number of submarines completed month by month over the same period.

(3) The gradual rise in cost per metric ton.

As regards (1), attention is drawn to the ordering of 220 submarines in 1918.

By the end of the war the shipyards of Germany were concentrating on the building of submarines and destroyers. Certain smaller shipyards also built minelayers and auxiliary vessels. It was arranged that shipyards specialising in destroyers, such as Schichau, Dantzic, and Vulkan Stettin, should not build submarines, whilst yards building submarines had either no destroyers in hand or in certain cases a few. In the rush to build submarines it was not unusual for parts of the yard never previously used for shipbuilding to be adapted to make building slips for the U boats.

To obtain this enormous output every form of labour-saving arrangement was adopted, principally in the direction of the standardisation of fittings and even integral parts of the boat. This course enabled material to be prepared in the engineering establishments in the country and sent in a form ready for immediate erection on the boat at the shipyard. It may be of interest to indicate a few of the schemes adopted. The torpedo tubes were standard both as regards their size but also their arrangement in the boats. Accordingly the forward ends carrying the caps and shutters were standard and could be attached to any hull. The conning towers were prepared with the hatches completed and the various brackets attached so that they could be dropped into position and secured. The pressure-tight bulkheads with water-tight doors, &c., were prepared complete in boiler shops and the outer angle was drilled ready to be put into the boats. The machinery as a whole was composed of groups of standard units. In short, the engineering establishments were utilised to the utmost to assist the shipyards.

The trials of these vessels also required a considerable staff, which had to be augmented from active service ratings as the number of boats increased. To facilitate the testing of the strength of the hulls the special testing and floating docks were used. The largest of these is shown in Fig. 5. It is large enough to take the largest U boat hull inside the cylindrical pressure chamber. On either side of the chamber docking blocks are provided, so that two U boats can be dry docked in the usual way. The pressure chamber is cylindrical and closed at one end. A specially fitted floating caisson closes the other end. In operation the caisson is removed and the dock as a whole submerged until the U boat can be floated into position. Then the caisson is replaced in its correct position. To secure it a series of grooves are fitted which can engage with wedges on the caisson. To tighten the door it is caused to revolve by pumping out a tank and so making it unstable. In addition to this there is provided a number of securing bolts. This dock enabled tests up to pressures corresponding to a submergence of 150ft. to be applied and the behaviour of the structure observed without difficulty. This dock has been surrendered to the Allies with all the salvage ships, &c., special to submarines.

The manning of the U boats caused the Germans much anxiety. The supply of trained *personnel* lagged behind the output of the yards, and as a consequence the crews consisted of partly untrained men. This, the Germans claim, is the explanation of some otherwise inexplicable mishaps on trials and of some of the losses on service which they sustained.

To assist the yards new to submarine work a U boat inspection commission was formed, which advised the builders as well as supervised the work. Skilled engineers from active service on the submarines were also attached to the various establishments.

The output of submarines increased steadily until at the Armistice in certain yards no other warship work was being done.

The published memoirs of Admiral von Tirpitz tell how the decision to adopt unrestricted warfare was only arrived at after considerable discussion and in spite of much opposition. Many Germans who realised the limitations of that type of war were not hopeful, but it was held out as the one way quickly to end the war, which by that time was causing the people as a whole great hardship and privation. In the hope that by its adoption their sufferings would be shortened, the people supported it. That it did constitute a very serious menace to the Allies cannot be questioned, but at no time did it break the blockade which had a strangle-hold on the enemy.

One of the terms of the Armistice was that all the submarines fit to travel were to be surrendered to the Allies and the remainder were to be broken up. It will be remembered how these U boats came to Harwich under their own power with German crews

TABULAR STATEMENT "A."—*German Submarine Construction During War.*

"U" Class.

Boat.	No.	Surface displacement.	Total.	Building yard.	Remarks.
		Tons.	Tons.		
U 29/30	2	675	1,350	Dantzic I.Y.	
U 31/41	11	685	7,535	Germania, Kiel	
U 42	1	—	—	Fiat, Spezia	Taken over by Italy.
U A	1	270	270	Germania, Kiel	Built for Norway, taken over by Germany.
U 43/50	8	725	5,700	Dantzic I.Y.	
U 51/56	6	715	4,290	Germania, Kiel	
U 57/62	6	768	4,608	Weser A.G.	
U 63/65	3	810	2,430	Germania, Kiel	
U 66/70	5	791	3,955	Germania, Kiel	Originally Austrian.
U 71/80	10	755	7,550	Hamburg Vulkan, 8 ; Dantzic I.Y., 2	
U 81/86	6	808	8,848	Germania, Kiel	
U 87/92	6	757	4,542	Dantzic I.Y.	
U 93/98	6	857	5,142	Germania, Kiel	
U 99/104	6	750	4,500	Weser A.G.	
U 105/114	10	798	7,980	Germania, Kiel	
U 115/116	2	798	1,596	Elbing, Schichau	Not completed.
U 117/121	5	1163	10,467	Hamburg Vulkan	U 121 not completed.
U 122/127	4	1163	4,652	Blohm and Voss	
U 126	—	—	—	—	
U 127/130	8	1163	9,304	Germania	Not completed.
U 131/134				Weser A.G.	Not completed.
U 135/136	2	1175	2,350	Dantzic I.Y.	
U 137/138	2	1175	2,350	Dantzic I.Y.	Not completed.
U 139/141	3	1930	5,790	Germania I.Y.	
U 142	1	2158	2,158	Germania I.Y.	Not completed.
U 143/147, U 148/150	8	2158	17,264	143/144 Germania, 145/147 Hamburg Vulkan, 148/150 Weser A.G.	Not completed.
U 151/157	7	1510	10,570	Germania, Kiel	
U 158/159	2	1510	3,020	Dantzic	Being built.
U 160/164	5	821	4,105	Bremer Vulkan, Vegesack	
U 165/172	8	821	6,568	Bremer Vulkan, Vegesack	Not completed.
U 173/176	4	821	3,284	Germania, Kiel	Not completed.
U 177/178	2	821	1,642	Bremer Vulkan, Vegesack	Not completed.
U 179/180	2	821	1,642	Weser A.G.	Not completed.
U 181/182	2	821	1,642	Blohm and Voss	Not completed.
U 183/184	2	821	1,642	Germania, Kiel	Not completed.
U 187	1	821	821	Germania, Kiel	
U 191/192	2	821	1,642	Blohm and Voss	Not completed.
U 201/212	12	821	9,852	Bremer Vulkan, Vegesack	Not completed.

"UB" Class.

Built.					
UB 1/17	17	127	2,159	Germania, Kiel, 8 ; Weser A.G., 9	15 ordered October and November 2nd, 1914, delivery commenced May, 1915.
UB 18/47	30	272	8,160	Blohm and Voss, 18 ; Weser A.G., 12	Ordered June, 1915, all delivered by March, 1916.
UB 48/132	85	516	45,924	Blohm and Voss, 26 ; Weser, A.G., 33 ; Blohm and Voss, 24 ; Germania, 6	Ordered May, 1916, and the 89 detailed were delivered by time of the Armistice.
UB 142/143	2				
UB 148/149	2				
Building.					
UB 133/141	9	516	4,644	Germania, Kiel	
UB 144/147	4	516	2,064	Weser A.G.	
UB 150/153	4	516	2,064	Weser A.G.	
UB 154/155	2	516	1,032	Vulkan, Hamburg	
UB 156/169	14	516	7,224	Vulkan, Hamburg	
UB 170/175	6	516	3,096	Germania, Kiel	
UB 178/184	7	516	3,612	Weser A.G.	
UB 188/205	18	516	9,288	Vulkan, Hamburg	

SUMMARY.—*Built.*—UB 1/17 Class, 17 ; UB 18/47 Class, 30 ; UB 48/149 Class, 89 ; total, 136. *Being built.*—UB 48/149 Class, 13 ; UB 150/205 Class, 51 ; total, 64.

"UC" Class.

Built.					
UC 1/15	15	168	2,520	Hamburg Vulkan, 10 ; Weser A.G., 5	
UC 16/79	64	410	26,240	Blohm and Voss, 24 ; Hamburg Vulkan, 21 ; Weser A.G., 7 ; Germania, 6 ; Dantzic I.Y., 6	
UC 90/105	16	491	7,856	Blohm and Voss	
Building.					
UC 80/86	7	410	2,870	Dantzic I.Y.	
UC 87/89	3	410	1,230	Weser A.G.	
UC 106/138	33	491	16,203	Blohm and Voss	
UC 139/152	14	491	3,874	Dantzic I.Y.	

SUMMARY "UC" CLASS.—*Built.*—UC 1/15, UC 16/79, and UC 90/105 ; total, 95. *Being built.*—UC 80/152 (ex UC 90/105); total, 57.

"UF" Class.

Building.					
UF 1/13	13	—	—	Elbing, Schichau	
UF 21/34	14	—	—	Techlenborg	
UF 39/44	6	—	—	Geestemundi	
UF 49/52	4	—	—	Seebeck, Bremerhaven	
UF 77/80	4	—	—	Atlas Werke, Bremen	

Total being built, 41.

and were there surrendered. Equally surely were the submarines under construction effectively destroyed. Fig. 6 shows a piece of a U boat ready to be taken away by the scrap steel merchant.

One method of using U boat hulls commercially has been devised. The sister vessels Ostpreussen and

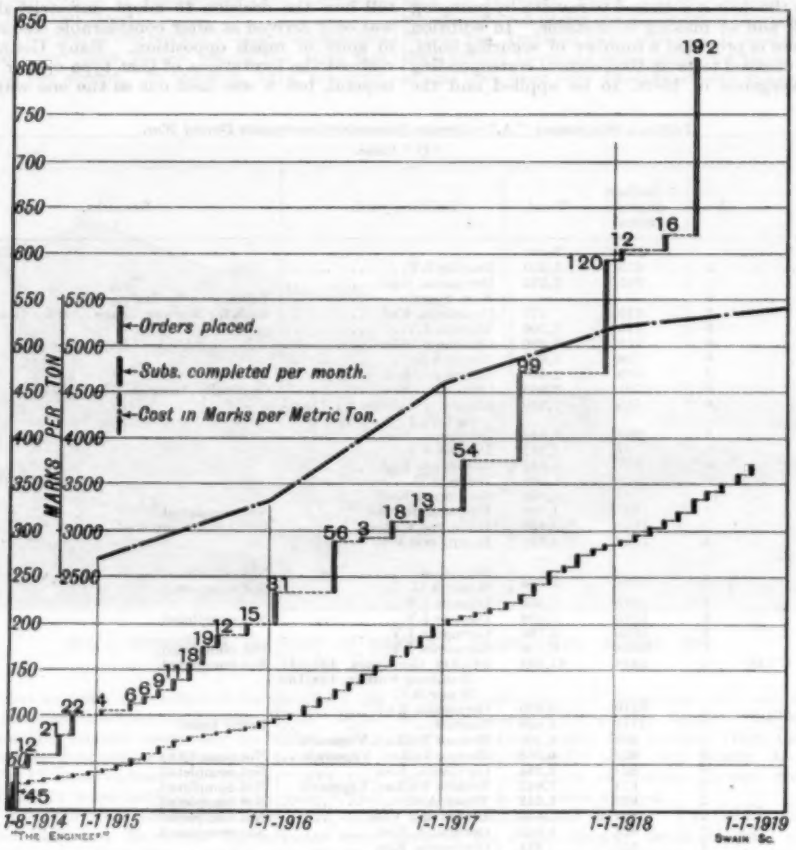


FIG. 4—CHART SHOWING RATE OF BUILDING AND INCREASE OF COST OF SUBMARINES

Oberschliesen are motor tankers built for the Stinnes' interests by the Germania Shipyard, Kiel. Each vessel is built up from two U boat hulls, the water and oil-tight construction of which renders them very suitable for tanker service. The principal particulars of the completed vessels are 287ft. long, 40½ft. wide,

FIG. 5—SUBMARINE PRESSURE TESTING AND LIFTING DOCK

and 3000 tons deadweight tonnage. The U boat hulls were each 250ft. long and 19ft. in maximum diameter. They were placed side by side, tied together, and surrounded by a structure to give approximately a ship-shaped form. The engines are *ex* U-boat Diesels of 700 brake horse-power, one in the after end of

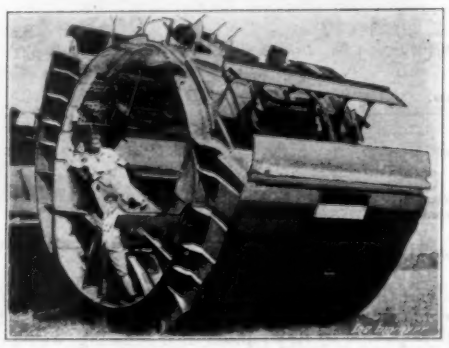


FIG. 6—BREAKING UP A SUBMARINE

each hull. Most of the auxiliaries are electrically driven, but a small boiler is provided to work the capstan gear and winches. The oil is carried in the pressure hulls mainly.

By the Treaty of Peace Germany is forbidden to build any submarine or submersible for any purpose whatever or to acquire any such vessel from outside the country. Thus all the while this Treaty is in force the U boat cannot form a part of Germany's fleet.

So has ended one of the most desperate ventures made by any country. The U boat was used in contravention of the existing rules of war, but owing to the blockade of the Grand Fleet and the counter measures of the Allies it failed.

The International Railway Association.

No. IV.*

Electric Traction.

On the subject of "Electric traction on lines with much traffic; production and transmission of energy; type of current; locomotives, motor cars; technical and financial results obtained; comparison with the results of steam traction," there are no less than seven reporters, and we present summaries of the contributions by Mr. J. J. W. Van Loenen Martinet, of the Netherlands State Railways, the reporter for Holland and Great Britain; Mr. George Gibbs, of New York, reporter for America; and M. Alfredo Donati, of the Italian State Railways, reporter for Italy.

In Holland the only example of an electrified railway, the Rotterdam-The Hague-Scheveningen line, belongs rather to the main line inter-urban kind, although the relatively long distance between stops (1.6 miles), the great number of through trains, the weight and speed of trains, give this line rather the character of a main line. The choice of 1500 volts as a standard for the direct-current system was only arrived at by the Dutch Electrical Committee after very exhaustive consideration. Third-rail construction has never been in favour in Holland, on account of the numerous private crossings and the bad soil, which necessitates very frequent working at the track. With an overhead construction there would have been much to say in favour of a voltage higher than 1500. But the consideration that multiple-unit motor car operation would be a prominent feature in railway electrification led the Committee to the choice of 1500 volts. Moreover, 1500 volts is now a standard pressure for motor car equipment. The distance apart of sub-stations had to be taken into consideration. With a density of traffic, such as is expected, it will be in the neighbourhood of 12 kiloms (7.5 miles), but with the automatic sub-station in view the future looks rather promising, and, taking all things together, the Committee is of opinion that with the present state of progress of the electrical industry 1500 volts is the right thing for Holland.

Mr. Gibbs' Report.—Mr. Gibbs, who was also the reporter on the same subject to the Berne meeting in 1910, opens his present report, reproduced in the December, 1921, Bulletin, by saying that he deals with the subject from the standpoint of a railway man who has been in contact with the technical details, but who is writing for those not specially versed in them.

Very little new mileage is under construction or contracted for at present in America, although there are three important projects determined upon which will be undertaken as soon as financial conditions warrant. Practically all railway service conditions have been successfully met. On the American and Canadian railways upon which electric traction is in use, in whole or in part, nine installations are employed for passenger, one for goods and nine for mixed passenger and goods services. These distinctions are not exact, as the ratio of goods to passenger in mixed services varies greatly, one or the other service being generally incidental to the main one. Essentially there are twelve railways electrified for passenger service and seven for goods. Or, more specifically, for city terminal operation (passenger), five; for long tunnel operation (passenger and goods), five; for suburban operation (passenger), three; for heavy grade operation (goods), two; for main line operation (passenger and goods), four.

There are two kinds of conductors in use: third rail and overhead. For general railway electrification there are important objections to a third rail:—

(*a*) It does not provide continuous contact through complicated track switches and crossings.

(*b*) It obstructs the track structure and interferes to some extent with maintenance of permanent way and track; it obstructs the spaces between tracks in yards and thus menaces the safety of employees in shunting work.

(*c*) It cannot be entirely enclosed and involves risk of contact by employees and others, the serious consequences of which increase as the voltage in the conductor is raised.

(*d*) Power to the train is subject to interruption when snow or sleet collects on the conductor.

Furthermore, the economy and flexibility of low-tension current, which is necessary with a third-rail conductor, is inferior to that of high-tension distribution which is permissible with an overhead conductor. Because of these various objectionable features, third-rail traction may be considered obsolete in America for heavy railway electrification.

The advantages of an overhead working conductor for heavy traction are:—

(*a*) It provides continuous contact at the train in places of complicated track lay-outs.

(*b*) It does not interfere with the maintenance of permanent way and track, and it may be employed safely with very high voltages.

(*c*) Uninterrupted service is assured from it to a greater extent than is the case with a third rail during sleet storms.

Its disadvantages are:—

(*a*) It is difficult to collect large currents from it.

(*b*) Difficulty and delay arise in making repairs to the contact system where traffic is heavy.

(*c*) It is difficult to install in cases of limited clearances at bridges, tunnels, &c.

Voltage Limitation in Overhead Conductors.—In case of the single-phase alternating-current system the maximum voltage is determined by the requirements for economical maintenance of electrical insulation of the live wires; 16,000 volts potential has been successfully used in Europe, and is probably as high as it is desirable to go. Proper insulation in the close clearances in tunnels and under bridges would be very difficult with higher pressures. A pressure of 11,000 volts has been generally used for existing single-phase installations and has been found suitable and sufficient for the sparkless collection of current at the locomotive used for the heaviest traction requirement.

Voltage in case of the three-phase system is limited by the necessity of maintaining insulation between two conductor wires of opposite polarity placed in close proximity to one another; experience in Europe appears to fix the practical limit at about 3000 volts. The use of the three-phase system has, however, not been seriously proposed for American railways, chiefly because of the complications in and expense of installing and maintaining the two overhead contact wires.

In case of a direct-current system having an overhead conductor wire the working voltage is limited by the maximum suitable for generating apparatus and in the control and motors on the train. In the present state of the art, 3000 volts appears to be the maximum allowable for such apparatus, and an even lower voltage is desirable. The reporter believes 3000 volts pressure is undesirably low to ensure reliable collection of the large currents required at the locomotive for heavy service, and especially at high speeds. It has been sought to remedy this defect of the system by using two contact wires placed side by side, but complication is increased, especially at switches, on curves, &c.

Electric Locomotives.—No approximation even to a standard electric locomotive design has been arrived at. The problems still ahead for solution are both electrical and mechanical; the former await the selection of a system and the development and perfection of apparatus; the latter relate to the working out of methods of transmitting power from the motors to the driving wheels and securing the best

* No. III. appeared April 14th.

type of locomotive structure for perfect tracking properties. It may be said, however, that the serious problems awaiting solution at present are mechanical rather than electrical; motors and control of both the direct-current and the alternating-current types work well; of the mechanical features little is known of a conclusive nature—experience has been too limited with electric locomotives. It would seem a simple matter to transmit the uniform torque of a rotating motor to a rotating driving wheel; it is so, within certain limits, if the possible effects of these rotating masses on the locomotive structure and on track be disregarded. A suitable design for a heavy modern steam locomotive has only been evolved after years of development and through progressive and small steps which have fixed the desirable inter-relation of wheel arrangement and weights, spring supports and heights of centre of gravity for the heavy masses; it is not a simple matter to produce an equivalent combination in an electric locomotive, especially for one which will equal the powerful tractive effort of a modern steam locomotive.

In the opinion of many—of which the reporter is one—axle weight has been carried far beyond the advisable limit, track conditions considered. But in steam traction there is now no way to retrace steps in this regard to an important degree, because modern railways, both physically and financially, must be operated with heavy train units.

In adopting electric traction, however, there is a possibility of returning to moderate wheel weights for locomotives without disturbing present operating methods. That can be done by stringing together locomotive units to make one compound structure singly controlled. Doing that would incidentally assist in solving some problems in motor construction, driving connections and wheels grouping; it has not been carried into effect chiefly because the high first cost of such an electric locomotive has deterred designers from proposing it. It must be admitted that no definite figures can be produced to prove the economies which would follow in track maintenance, as these are not susceptible of reduction to exact figures. However, the suggestion is made as one which should be worthy of some thought, perhaps to be carried into effect later. Up till now the high concentrated wheel weights of the steam locomotive—for the reasons of compactness and lowest first cost—have been used in electric locomotives. Weights as high as 70,000 lb. per axle are employed, and this concentration has accentuated the difficulties of applying and coupling the motors to the wheels in a proper manner.

The Pennsylvania Railroad has built a very powerful goods locomotive, in anticipation of an extensive electrification of its main line over the Allegheny Mountains. This locomotive embodies many of the electrical and mechanical features of the Norfolk and Western Railway locomotive, but has a larger motor capacity and many new details, which the company desired to test before it became necessary to order a large number of locomotives. It has been under trial for the past two years in goods pusher service on the electrified line of the company at Philadelphia.

The wheel arrangement is 2–6 + 6–2. Structurally it has a single cab mounted on two trucks, forming an articulated wheel base. Each truck consists of three coupled driving axles and a forward radial single axle. Three-point suspension is secured by equalising the driving axles, the centrally supported leading truck forming the third point. The cab is supported between the first and second pairs of driving wheels and has two side spring supports.

Mr. Gibbs' Conclusions.—(1) The type of locomotive where the motors are direct geared to the axles is suitable only for slow-speed locomotives, such as those for shunting or goods services. For the heaviest requirements of goods haulage, however, it is doubtful if this type is the best. Quill-driven geared motors should produce better results in the above respects, but only in degree. A quill drive has not been entirely satisfactory for heavy service, because, mechanically, it is difficult to find space for conservatively designed springs, and if the quill is not maintained normally concentric with the axle severe bending stresses are set up in the springs at each revolution of the wheels, whereas a helical spring should be subjected to torsional stresses only. Therefore, quill drive appears to have a distinct limitation in successful application to electric locomotives.

(2) The type with gearless drive which has the motor armature mounted rigidly on the axle, requires many axles for heavy traction, and a locomotive wheel arrangement which is somewhat complicated and unfavourable for tracking.

(3) The same type, having gearless motors flexibly suspended around the axles, may be used for high-speed passenger locomotives with either direct-current or alternating-current traction, but it is not an economical type as regards first cost of motors and it has a low centre of gravity of the running gear.

(4) The type with gearless drive by means of cranks and rods is suitable for high-speed passenger work with both direct-current and alternating-current motors, and allows the most desirable wheel arrangement and weight distribution for perfect tracking qualities of the locomotive. The motors, however, are very large and costly because of their low speed, and their capacity is limited; the type is not suitable for low-speed service.

(5) The type with geared motors and a rod drive offers the most flexible and promising solution for passenger and goods locomotive construction, because of the allowable variation in wheel arrangement and in motor mounting and capacity; it permits most perfect tracking qualities for a great variety of designs and running speeds. It is suitable both for direct-current and alternating-current traction systems.

Coupling-rods connecting the various driving wheels are desirable in all types to prevent slipping of independent axles and to thus obtain maximum traction, especially with direct-current motors having series-multiple control.

This report is accompanied by thirty-five diagrams and photographs, an appendix giving a synopsis of important installations, and six tables.

Italian Experience.—Mr. Donati (December, 1921, Bulletin), after dealing with the details and progress of existing schemes in Italy, says that the new programme for the extension of electric traction in Italy, which was drawn up by the Administration of the Italian State Railways in common with the Government, anticipates the electrification of about 4500 kiloms. (2800 miles) of railway which had been selected with care from amongst those which, owing to their gradients and their heavy traffic, now consume the greatest quantity of coal. When this programme has been carried out it will effect an annual saving of about 1,250,000 tons of coal and will consume about 600,000,000 kilowatt-hours per annum, with about 180,000 kilowatts of electric power installed in the central generating stations.

The electric power for these new electrified lines will generally be purchased from electric power distribution companies, but the Italian State Railways themselves are carrying out important hydro-electric installations so selected that at least one main central station, running in parallel with the central stations of the companies, will be placed on each section of the railway system shortly to be electrified.

Electric Locomotives.—The great simplicity of the three-phase induction motors, together with their great strength, enables the three-phase locomotive to be made more simple and lighter than is possible with other systems of electric traction. The Italian electric locomotives require to have a weight per axle not exceeding 15 tons, which is the limit of load on the greater number of railway bridges. On the other hand, the normal tractive effort must not exceed 10 tons in order that it may not subject the draw gear of the wagons and carriages to stresses in excess of what they can carry. The most powerful Italian locomotives have been so designed as not to exceed either of these two limits. It has been found possible to build electric locomotives satisfying these conditions, capable of a speed of 75 kiloms. (46.5 miles) per hour and having a total weight of 75 tons.

Results.—The traffic which, on the two Giovi lines before electrification, was about 500 million virtual ton-kilometres (306 million virtual English ton-miles) hauled per annum, had increased a few years after electrification to about 1200 million virtual ton-kilometres (734 million virtual English ton-miles) hauled. Similarly, on the Bussoleno-Modane line the traffic, which, before electrification, was about 110 million virtual ton-kilometres (67 million virtual English ton-miles) per annum, attained in recent years a mean of 400 million tons (245 million virtual English ton-miles) with a maximum of 514 million tons (314 million virtual English ton-miles) in the year 1918. The same increase of traffic has been found approximately on the Savona-Ceva line—150 million tons before electrification and 450 million tons after electrification.

One of the reasons that had permitted the working of the Italian electrified lines with so heavy a traffic is the uniformity of speed which is one of the special characteristics of the system of three-phase traction. This constant speed actually permits all the trains to follow regularly at equal intervals, and one is sure that, apart from cases of failure of the electric locomotives, which the statistics of the yearly service have shown to be extremely rare, the trains adhere to the time-table. The regularity of speed, which had been one of the first anxieties in the installation of electrification with three-phase current, has also been recognised as being of great value with regard to the working of the traffic.

The economy in coal obtained on the electrified lines of the Italian State Railways during recent years was from 150,000 to 180,000 tons per annum; the mean cost of this coal was for these years 300 lire per ton, so that a mean economy of about 50,000,000 lire per annum has been effected, to which must be added other economies resulting from electric traction.

This economy for the expenses connected with traction alone (exclusive of coal) was about 1,500,000 lire each year. The cost of electric power and of maintenance of the installations only amounting to to about one-fifth of the single item of the economy on coal! These very favourable results are due in great measure to the war, which produced an extraordinary rise in the price of coal in Italy, but the comparison would still be favourable, though only to a smaller extent, if coal were at the pre-war price.

These results are very clear and conclusive; it can be seen that under the conditions named an economy would always be effected in Italy by electric traction if the cost of coal had been about 50 lire per ton. It can also be seen that the economy is greater the more important the line electrified. This is independent of other economies of working, which are difficult to calculate exactly, *i.e.*, reduction in the wear of the rails due to electric braking, absence of smoke in the tunnels, reduced expenditure on maintenance of all the rolling stock, wagons and coaches, economy in carriage of coal which would have had to be burnt instead of the electric power supplied, &c. It must also be noted, as has already been stated, that all expenses relating to electric traction will diminish with a rational extension of the electrified system, and that the comparison is, moreover, destined always to become more favourable to electric traction, because care has been taken to select the new lines for electrification from amongst those on which the traffic is most dense and which form a continuation of the systems already electrified.

It is thought that the question of the system of electric traction has been given far too much importance in the numerous discussions which have been made on it in the technical Press. From the technical point of view, in Italy, the three-phase low-frequency system in the form in which it has been adopted on nearly all the lines electrified up to the present has given complete satisfaction; the continuous current system, with the third rail at 650 volts, which was adopted on the Milan-Varese-Porto-Ceresio line, also answers very well to the special needs of this line, which has light traffic and a large number of passenger trains.

From the economic point of view it is believed that the difference between the three-phase system and that of the high-tension continuous current is almost negligible. In the first place, it may be noted that the cost at present per electric train kilometre in Italy is about 2.40 lire. On this figure the general cost of working of staff, of station employees, &c., which are outside the station costs, have an absolutely preponderating importance amounting to about 2 lire per train kilometre. The remaining 0.40 lire, that is to say, 16 to 17 per cent. of the total cost of working, represents the cost of traction on which the question of the system adopted might have some influence. A small difference of expenditure, more or less, which might be made on this portion of the total figure becomes almost inappreciable on the total; 5 per cent. becomes, for example, 0.85 per cent. on the total expenditure. Looked at in this light it will be seen that any other detail of the working may have a greater economic importance than that of the electric systems adopted. It is still believed that the question of having a single electrical system over the whole railway system, whatever it may be, is of greater economic importance than the question of the actual system selected. In fact, this unified system leads to the much more complete utilisation of electric energy, of the plant, and of the staff, than when adjacent sections are worked by different systems.

Locomotive Cab Signals.

In Section III. reports are presented on terminal stations for passengers, goods stations, slow goods traffic, and locomotive cab signals. In view of the interest aroused in the last question and the Ministry of Transport Departmental Committee on Automatic Train Control, we would say that the report (November, 1921) of M. F. Maison, of the Technical Service of the French State Railways, who reported for France, but whose name is not on the official list of reporters, says that the repetition of signals is a necessity; that it should be an audible and not a visual signal; and that "it is useless, and may even be dangerous, to act upon the brake apparatus of the train in such manner as to cause automatic stopping, even when the driver is left free to cut out this action of the brake." A second part of this report recommends speed recorders "so that all the conditions of the run can be determined."

Section IV. is devoted mainly to rates, customs examination, interchange of rolling stock, and workmen's dwellings.' Section V. deals with light railways.

Liquid Fuel in Locomotives.

Sir Henry Fowler, chief mechanical engineer of the Midland Railway, submits (August, 1921, Bulletin), a note on the use of liquid fuel in locomotives.

Therein it is said that in 1913 the number of *questionnaires* sent out was 157, and of this number only thirty-two administrations stated that they were using or had experimented with liquid fuel, while on only thirteen administrations was it used at all extensively.

In 1920 the number of *questionnaires* sent out was ninety-four, and of this number only fourteen administrations had any information which it had been thought necessary to reproduce, and on only seven administrations was the use of liquid fuel at all extensive, while on one of the latter the use of oil had been discontinued for the time being on account of its scarcity. In all cases the systems used are those which necessitated little or no alterations to the structure of the standard locomotive fire-box. The variation of the systems consists chiefly of the form and position of the burner and bricking arrangements in the fire-box.

The extra cost of fitting apparatus is in no case high. Liquid fuel seems to present no special advantage with any particular type of locomotive, *i.e.*, passenger or goods. In some cases it is applied for work in tunnels owing to the possibility of generating

steam with no smoke when careful adjustment of the apparatus is made, whilst in other cases the fuel is employed during summer months in forest regions owing to its freedom from sparks. One administration used to employ liquid fuel to supplement coal on heavy gradients, but since the introduction of superheated steam this course has been found unnecessary.

After reciting the advantages of liquid fuel, Sir Henry says that, against these advantages, great as they are, must undoubtedly be placed the question of increased expense, except in a few special localities. This expense arises primarily from the cost of the oil, which has increased considerably during recent years, and in view of its increased and increasing employment for internal combustion engines and for firing marine boilers, the price is not, to say the least, likely to drop to a great extent unless some considerable change in its supply and use takes place. It must be borne in mind that any extensive use of oil for producing steam in the locomotives of the world would undoubtedly lead to a further increase in price. It is also of doubtful advisability to extend the practice of burning oil for the purpose of raising steam, as by so doing we divert a commodity, the supply of which is by no means unlimited, from its more efficient *rôle* in internal combustion engines. Each class of fuel, solid and liquid, has its own type of prime mover to which it is best suited, and should, broadly speaking, be used accordingly.

In addition to the question of cost of fuel itself, the question of any increased cost in maintenance has to be considered. Although several of the administrations have stated that the use of liquid fuel does not increase this cost, the majority are equally definite in stating that the intense heat generated has a greater detrimental effect on the boiler than solid fuel.

It would seem, on the whole, that, except in certain neighbourhoods in the vicinity of oilfields and remote from suitable coal, the expense of liquid fuel is too great to render the question of its adoption of practical value.

There is another point with regard to the employment of liquid fuel on locomotives to which Sir Henry refers, and that is its use in internal combustion engines, in which recent advances have made the employment of heavy crude and cheap oils possible. Lately the question of the construction of internal combustion locomotives of powers comparable with those of ordinary steam locomotives has been considered, and some move has already been made in this direction. The main difficulty is presented by the gears, as the torque of such machines is practically constant, with the result that the locomotives are liable to be slow in starting on heavy gradients. This matter is one which is receiving considerable attention at the present time, and will doubtless continue to do so, especially in countries where the water supply presents difficulties.

During the past few years the use of what is known as colloidal fuel has been experimented with. It is made by mixing a fuel oil with a percentage of finely divided coal dust, and it is hoped that if success is achieved the use of a certain amount of cheap fuel, like coal dust, may be possible on locomotives.

New Type of Concrete Truss Bridge.

A NOVEL method of construction for concrete truss bridges which has been used recently in America is the pouring of concrete in forms or moulds laid flat upon a platform, the trusses being turned up on edge or in a vertical plane after the concrete has set. This method, which has been employed in the construction of some large highway bridges, is the invention of Mr. T. V. Jenkins, of the Jenkins Bridge and Construction Company, of Denver, Col. The bridge over the Wichita River at Wichita Falls, Texas, has six spans of 66ft. between centres of piers, with a 20ft. roadway between the trusses and two 4ft. footpaths outside of the trusses. Another bridge at Las Alamos, New Mexico, has four spans of 80ft.

For the construction a pair of temporary light steel trusses are placed on the ends of the piers outside the line of the concrete trusses, and their bottom booms carry a floor or deck for the moulds in which the concrete trusses are cast. A slight camber is given to this floor in order to avoid a longitudinal curvature in the trusses. The quantities of sand, cement and stone or gravel for the two trusses are placed in sacks which are distributed uniformly along the span, so as to obtain the full deflection in the floor. This deflection is maintained, of course, by the weight of the concrete made from this supply of materials.

When the trusses are ready three differential chain hoists are attached to cross beams resting on the top booms of the steel trusses and to slings wrapped around the top boom of one of the concrete trusses. In this way the truss is raised to a vertical position and set in place on the piers. The opposite truss is then raised and placed in the same way.

When the two concrete trusses are in place, rollers are attached to the posts of the steel span or traveller in such position as to ride on the top booms of the concrete trusses. The steel span is then launched or moved ahead until it projects partly over the space for the next span. Its bottom booms are then fitted with rollers which bear against the underside of the booms of the concrete trusses, and thus anchored, the traveller is advanced as a cantilever until it reaches a bearing upon the next pier. This steel traveller is 94ft. long, and to provide for its use the piers are made with recessed seats at the ends, so that the floor system of the traveller carries the platform or deck of 1in. plank at the elevation of the bottom of the concrete trusses.

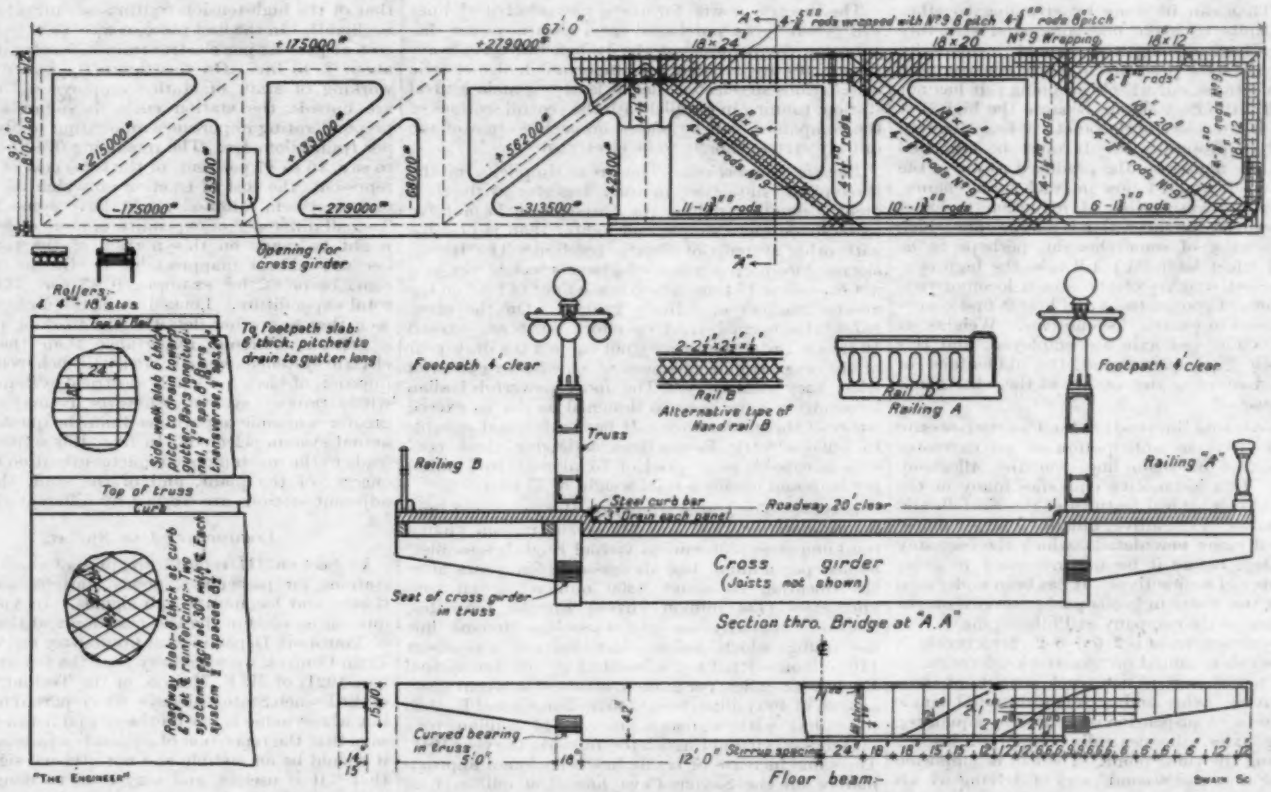
The traveller can be taken down and re-assembled for different concrete bridges, but in some cases it has been sold for use as a steel bridge. This curious condition is due to the fact that all these concrete bridges have been built in lightly settled districts where road work is active and where there is a demand for bridges The steel span or construction traveller is designed with a view to this double purpose. A special advantage claimed for this method of bridge construction is that it avoids the use of the ordinary falsework or scaffolding between the piers, thus eliminating the danger of settlement in soft ground and of a washout by floods, which, in carrying away the falsework, may cause the loss of an unfinished span which it supports.

With the traveller moved ahead so as to be clear of the concrete trusses, timber beams are laid across the top booms of these trusses, and from the beams are suspended the forms or moulds for the cross girders or floor beams, including the brackets or cantilevers which support the footpaths. Horizontal bolts are embedded in the cross girders to serve as attachments for the moulds of the floor joists and slab. After the concrete had been poured for the joists and slab or floor, the bolts were knocked out of the girders, allowing all the moulds or form work to fall away. The bolt holes were then filled with mortar.

The several stages of this interesting method of bridge construction are illustrated by the series of engravings which is given on page 442. Fig. 1 shows the steel span or traveller with the steel reinforcement for the concrete trusses laid out upon the floor. Fig. 2 shows one of the 66ft. 40-ton trusses being raised into position by the chain hoists, while at the right the other truss is still lying flat. In Fig. 3 the left-hand truss is in place upon the piers. Fig. 4 shows both trusses in place and the cross girders completed. Note the attachment bolts in the girders, as mentioned above. In the next span the moulds for the cross girders are suspended from wooden beams laid across the concrete trusses. Fig. 5 shows the partly completed floor and outside pathway. Fig. 6 shows the finished span with trusses, floor and hand railings. In Fig. 7 three spans are shown at different stages. The first one at the left has the steel traveller in place; the next one has the two trusses completed; and the third has the moulds in place for the floor beams or cross girders. In Fig. 8 the portion at the right is completed; the next two spans have the cross girders also in place, and in the end span the concrete trusses are being built on the steel traveller.

In the concrete truss design, shown in the accompanying drawings, the top boom and diagonals are in compression, which is taken up by the large concrete members. The bottom boom and verticals or posts are in tension, which is taken up by the steel reinforcement. This arrangement is said to make a very economical design for spans up to 75ft. By pouring or casting the trusses in flat position the amount of moulds or form work is reduced about 50 per cent.; furthermore, the forms are very simple, being merely a series of troughs laid on the wood floor and readily secured in position. In these troughs it is a particularly easy matter to place and adjust the steel reinforcement and to pour and tamp the concrete. The cost of bridges built in this way has been materially lower than the tenders for concrete arch bridges at the same sites.

The Wichita River bridge was designed for a live load of 150 lb. per square foot, or a 20-ton steam roller on two axles spaced 10ft. between centres, with 66 per cent. of the weight on the front axle. For the dead load the concrete is assumed to weigh 150 lb. per cubic foot. All concrete is composed of one part Portland cement to two parts sand and four parts gravel or stone. The trusses are 9ft. deep and the cross girders are 3ft. 6in. deep and 15in. wide. The roadway slab is 9in. thick at the middle and 8in. at the sides. It is reinforced by two layers of bars laid diagonally in opposite directions at an angle of 30 deg. These are ¾in. square bars spaced 8½in. between centres. The side walk slabs are 6in. thick, reinforced by longitudinal bars of 8in. spacing and transverse bars of 24in. spacing. All bars are ½in. square. The rounded nose of the kerb is protected by a steel kerb anchored to the concrete. Each truss weighed 40 tons, exclusive of the cross girders.



DETAILS OF REINFORCED CONCRETE BRIDGE TRUSS

CHEMICALLY pure zinc sulphide was prepared by R. Tomascek. It showed, after it had been illuminated, either no phosphorescent light, or so little as to be almost invisible. As the material approached chemical purity, the phosphorescent light became less. When a heavy metal was introduced into such a mass of zinc sulphide it became phosphorescent. For example, .000006 gramme copper per gramme of the sulphide produced a beautifully glowing substance. The method of crystallisation of the compound seems to have no influence on the result.

A Seven-Day Journal.

Sir Ross Smith.

On Wednesday of last week, in the company of others, we had an opportunity of inspecting at Vickers' Weybridge works the amphibian machine on which Sir Ross and Sir Keith Smith and Mr. J. M. Bennett intended to set forth on Anzac Day in an endeavour to fly round the world, and of personally wishing Sir Ross the best of luck in his bold adventure. And now one more tragedy has been swiftly added to the already appalling list of disasters for which man's "conquest" of the air has been responsible. On Thursday morning, after the machine had been flown for half an hour by the builders' test pilot, Sir Ross Smith, accompanied by Mr. Bennett, took charge of it for the first time. From the evidence forthcoming at the inquest it would appear that the machine and its engine were in perfect working order. There can, in fact, be little doubt that Sir Ross, unaccustomed to the control of an aeroplane of the flying boat type, and, as it would seem, somewhat out of practice generally, allowed the machine to get into a spin at a height too low to permit him to recover control before striking the ground. To a war record with which many would have been more than willing to rest content, Sir Ross added the lustre of his historic flight to Australia. Inspired solely by his intense love for flying, he was about to set forth on an adventure that would have surpassed in daring and the endurance required for its accomplishment anything he had previously attempted. That he, one of the world's most skilful pilots, using a machine of a type that has been thoroughly tested, should have lost his life in an aerodrome accident as the result of what must be regarded as an error of judgment on his part is sad testimony to the narrow margin between safety and disaster that even yet accompanies the practice of mechanical flight.

The Building Trades Exhibition.

A visit to the Building Trades Exhibition at Olympia leaves us with a distinct impression that little progress has been made in the industry since last year. The woodworking and concrete machinery on show presents, with one or two exceptions, little novelty, although the amount exhibited is at least as great as was the case twelve months ago. In the matter of fittings and materials, too, the exhibits are to a large extent already familiar. We noted with interest the use of blankets stuffed with seaweed as a means of insulating rooms from sound, and the development of some new and very beautiful paints by a firm formerly one of the largest producers of aeroplane dope. Our attention, too, was attracted by the appearance of bath and lavatory taps made, we were assured, from the wonderful Y aluminium alloy which Dr. Rosenhain and his collaborators discovered at the National Physical Laboratory in the course of their recent researches. By means of this metal applied in this way a solution would appear to have been found to the hitherto insoluble problem of how to reconcile the housewife's requirements in the way of taps with those demanded by the water supply authorities. The variety of bricks, ordinary and of special form, on exhibition was striking. In this connection one of the most pleasing effects in the whole hall was secured in a small half-timbered house the walls, fireplace, floor and roof tiles of which were made of Hampshire terra-cotta.

Franco-British Aero Engines.

In the early days of aeronautics, even, in fact, up to the outbreak of the war, this country was very largely dependent upon France and other continental countries for the supply of aero-engines. When, too, we did start to make our own there was a strong tendency to adopt foreign designs rather than to evolve original types. The Gnome, Le Rhone, Canton Unné, and Austro-Daimler engines arise in one's mind in this connection. Subsequently, however, when manufacturing experience had been gained, British designed engines began to play an important part in building up our aerial equipment. To-day the British machine with a foreign engine is next to unknown. A step farther has now been taken, for not only are foreign aircraft constructors occasionally adopting British engines for their machines, but are showing signs of doing so to an extent which it is believed will justify the manufacture of such engines under licence in their own countries. In this connection we note that the Bristol Aeroplane Company has concluded an arrangement whereby the sole licence to manufacture in France the well-known 400 horse-power "Jupiter" static radial air-cooled engine has been accorded to the Gnome and Le Rhone Engine Company. The announcement of this concession synchronises appropriately with the publication of the rules and conditions governing the aero-motor competition which, under the auspices of the French Committee for Aerial Propaganda, is to open in March, 1924. This competition, for which prizes amounting to two million francs are promised, will be distinguished by the fact that the competing engines will be required to undergo an endurance test on the ground over the extraordinarily long period of 240 hours, the tests to be completed in periods of eight consecutive hours within a maximum total period of 100 days.

The First Aerial A B C.

The first aerial time-table on the A B C pattern has made its appearance. It is a small forty-page pamphlet, published by the Standard Air Press, of 36, Shaftesbury-avenue, W. 1, and is to be issued monthly. While it is certainly too much to say that the relatively meagre use being made of the existing air services is to be ascribed to the insufficiency of the information available concerning them, it is undoubtedly true that a compilation of this description, giving as it does not only the times of departure and arrival and the fares for the services so far established, but many particulars regarding the Customs regulations, passports, the interconnection of the services among themselves and with the continental and British main line trains, and so on, should do a great deal to facilitate passenger and goods traffic on the airways. The number of aerial services now in operation on the Continent is probably not generally realised, and to take full advantage of them in the absence of an authoritative time-table must be next to impossible for the average business man. It may, perhaps, be recalled that in our issues of September 29th and November 3rd, 1911, we gave particulars of two early issues of Bradshaw's railway guide for 1847 and 1840 respectively. The new aerial guide is scarcely smaller than these were; will it, we wonder, one day reach the same development as they have done?

The Regulation of Road Vehicles.

The second interim report of the Departmental Committee on Taxation and Regulation of Road Vehicles contains several recommendations and suggestions which, if carried out, will have a considerable effect on the makers and users of motor vehicles. It is proposed that mechanically propelled vehicles should be re-classified into six groups, as follows:—Locomotives, heavy and light; heavy motor cars, including tractors; agricultural tractors, motor cars, motor cycles, and exceptional vehicles. The abolition of the existing speed limit of 20 miles per hour is recommended for private motor cars. It is not, however, intended that the restriction on the speed of heavy motor cars, locomotives, &c., should be removed, for the speed of such vehicles is regarded as a serious factor in relation to road damage and damage to property by vibration. The Committee does not consider that there is any justification for prohibiting or restricting the use of cars with left-hand drives provided the driver can give the proper traffic signals. If a vehicle is so constructed that the driver cannot observe or hear overtaking vehicles it should be equipped with mirrors or sound-receiving devices. The Committee urges that the Minister of Transport should reconsider the question of fitting mudsplash guards as soon as satisfactory appliances of this nature have been devised. He should also be empowered to construct trial road lengths and vehicles for experimental purposes, to make regulations requiring the use of efficient spark arresters, and to permit the use of gas as fuel only under special licence.

Treasury Loans to Facilitate Trade.

A White Paper issued by the Treasury records that up to March 31st it had been arranged to guarantee the principal and interest on sums totalling nearly 15 million sterling under the Trade Facilities Act. The periods over which the guarantees extend range from four to fifty years, and the sums guaranteed from £4700 to £6,700,000. The latter figure represents the loan to the South-Eastern and Chatham Railway for the electrification of its suburban lines. The next largest loan is one of £5,000,000 to the Underground Railway for the enlargement of the City and South London tunnel and other works, as recorded separately in another note. To Harland and Wolff £1,493,345 are to be lent for the purpose of establishing ship-repairing works on the Thames and effecting improvements at the firm's Meadowside and Greenock shipyards. Wm. Beardmore and Co. are to receive a loan of £600,000 for the completion of a vessel for the Lloyd Sabaudo Company of Genoa. Half a million sterling is being lent to the Calcutta Electric Supply Corporation for the purchase and installation of additional generating plant, cables, transformers and mains. To Palmer's Shipbuilding Company £300,000 are guaranteed for the construction of the new dry dock at Swansea, to which reference was made in last week's Journal. The Rhymney Valley Sewerage Board is to receive £250,000 for a drainage and disposal scheme in the Rhymney Valley districts. These seven undertakings absorb the bulk of the total sum guaranteed. The remainder is divided among an equal number of other firms.

The London Underground Scheme.

The Treasury loan of five million pounds to the Underground Railway is to be expended, in addition to the enlargement of the City and South London tunnel, on the improvement of stations, the provision of new rolling stock and the extension of the London Electric Railway from Golders Green to Edgware. The widening of the City and South London tunnel has long been contemplated, for this railway is the oldest tube railway in the world, and has been seriously restricted by its dimensions. It cannot accommodate the rolling stock of the other tube railways in London, and by increasing its size, traffic, it is expected, will be augmented by from 50 to 100 per cent. Many preliminaries have yet to be settled, but as soon as they are disposed of work will be begun and employment will be found for some six hundred men at once, with more to follow later on. The Edgware extension will be five miles long, mostly in the open, but with about a quarter of a mile of tunnelling. The work is expected to occupy about eighteen months, and will give immediate employment to about 1400 men. It will involve a considerable amount of excavating and embanking, and, in addition, will call for the erection of eight steel bridges and several viaducts.

The Clyde's Share.

So far as the Clyde is concerned, it would appear that something like two million pounds will fall to be expended in the neighbourhood under the Treasury loan scheme. Of this sum, £600,000 are allocated to Messrs. Beardmore for the completion of the Lloyd Sabaudo liner Conte Verdi, a twin-screw geared turbine vessel of 18,000 gross tonnage. Work on this vessel is at present suspended, apart from the shipyard strike, on account of the high costs of construction, but as the firm has already completed a sister ship, the Conte Rosso, immediate employment will be found for a considerable number of workers as soon as the financial arrangements are completed without the usual lapse of time required for the designing stage. The loan to Harland and Wolff, other than the portion relating to the Thames ship-repairing scheme, will presumably be in part expended in developing and improving the yards at Meadowside and Pointhouse formerly owned by D. and W. Henderson and A. and J. Inglis respectively. These two establishments adjoin each other, and came under the control of Lord Pirrie in 1917. The principal work to be undertaken will, it is probable, consist of widening the entrance to the Meadowside dry dock constructed by Tod and Macgregor in 1858 and of constructing a new fitting-out wharf. At Greenock the firm will expend a portion of the loan on the extension and improvement of the yard formerly owned by Caird and Co. This work is already in hand, but has been delayed by the high costs of labour and materials.

The Engineering Dispute.

On Friday of last week, the conference between the engineering employers and the Negotiating Committee of the three groups of unions, other than the Amalgamated Engineering Union, came to an end, it having become apparent that for the time being at all events there was no hope of reconciling the views of the two sides. The three groups of unions are now once again back in the place in which they were before they parted company with the Amalgamated Union. The employers offered so far as possible to give ten days' notice to the workpeople directly concerned or their representatives in the shop before introducing a material alteration in the recognised working conditions, and during this period to afford them an opportunity of discussing the matter with the management. The union representatives, however, objected to leaving the decision as to when the effect of an order was to be regarded as constituting a material change in the workshop conditions solely in the hands of the employers, and, moreover, insisted that in the discussions the workpeople or their shop representatives should receive the assistance of an outside trade union official. The employers regarded these proposals as an absolute negation of their right to manage their works. They, however, offered the workpeople the security of a direct and immediate appeal to a central conference, with a view to obtaining its decision as to whether any particular management was fulfilling the spirit as well as the letter of their proposed course of procedure. Even so, however, the unions could not agree to the proposal, with the result that the negotiations, as reported, broke down. Yesterday—Thursday—a full meeting of the executives of the three groups of unions was held, and the hope was expressed that a basis for the resumption of the negotiations would be found. The employers are stated to have "decided on the policy which is to be followed," but what that policy is to be has not been disclosed up to the moment of going to press. So far, the postponed lock-out notices have not been re-posted.

Battery Locomotives for Industrial Shunting Yards.

WHILST much has been said and written during the last few years concerning the merits of battery locomotives for certain kinds of service, there are undoubtedly many manufacturers who have not as yet seriously considered the question of what is likely to be saved by employing them instead of steam locomotives in industrial shunting yards. Shunting, or the movement from place to place of raw materials and finished goods, is a non-productive form of service, and its cost is usually included in the general factory expenses rather than in the cost of production. In many instances no very accurate records of the transport expenses are kept, and it is therefore not always easy to decide whether a change from an old to a new system of working is justifiable.

With a view to throwing light upon the cost of the electrical systems, however, the engineers of the traction department of the Metropolitan-Vickers Electrical Company have prepared some curves which enable the energy consumption of an electric battery locomotive service to be estimated for a given average daily cycle of operations, and it is considered that the results shown by these curves will be of sufficient interest to make the work of carefully estimating the cost of existing steam services well worth while. Calculations have been made for a series of operations performed by a battery locomotive of 14 to 15 tons adhesive weight and fitted with a standard tramway equipment. The track is assumed to be level and to be properly maintained and the rolling stock hauled to be of the standard railway type. Under these conditions, and allowing for the curves to be negotiated in a shunting yard, the track resistance would, it is considered, amount on an average to 15 lb. per ton at a speed not exceeding 10 miles per hour. The curve, Fig. 1, gives the energy consumed in watt-hours per ton-mile and is plotted against the length of the run in miles. The full-line curve shows the energy per ton-mile of net trailing load, and the dotted curve the energy per ton-mile required for the gross train weight, which, of course, includes that of the locomotive. Values for intermediate loads can obviously be estimated by taking points between these curves. With the aid of curves shown in Fig. 5 the time taken for runs of various lengths and with loads varying from 25 tons to 120 tons can be obtained, the distance in miles being plotted against the time in completing the journey between the times of starting and stopping. Another energy consumption curve, which is identical with the consumption curve for the maximum load—Fig. 1—is shown in Fig. 2, and above it is a curve showing the energy taken from the charging plant and calculated on a watt-hour efficiency of the battery of 75 per cent.; whilst the lower line represents the work actually done in moving the load.

By means of these curves it is possible to estimate the energy consumption of electric locomotives under actual service conditions, but it will, of course, be necessary to make an addition to the figures obtained if the engine works on gradients. It is necessary to note, however, that if the loads are similar on the up and down journeys and if the gradients are such that braking in excess of that allowed for in the calculation is unnecessary, the extra energy required for the up gradients will be regained on the downward run.

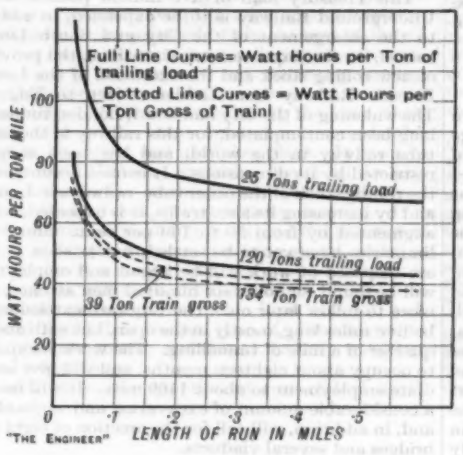

Full Line Curves= Watt Hours per Ton of trailing load
Dotted Line Curves = Watt Hours per Ton Gross of Train
25 Tons trailing load
120 Tons trailing load
39 Ton Train gross
134 Ton Train gross
WATT HOURS PER TON MILE
LENGTH OF RUN IN MILES
"THE ENGINEER"

FIG. 1

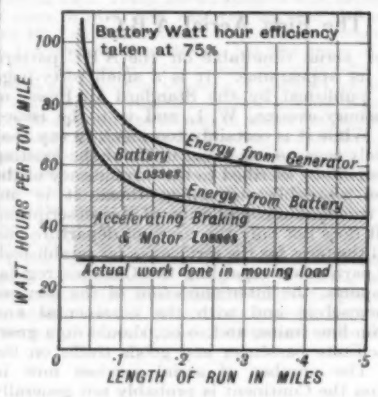

Battery Watt hour efficiency taken at 75%
Energy from Generator
Battery Losses
Energy from Battery
Accelerating Braking & Motor Losses
Actual work done in moving load
WATT HOURS PER TON MILE
LENGTH OF RUN IN MILES

FIG. 2

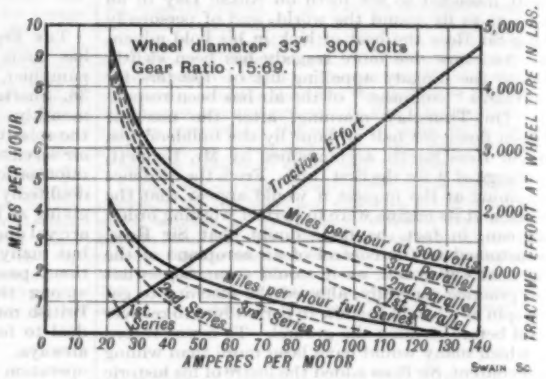


FIG. 3

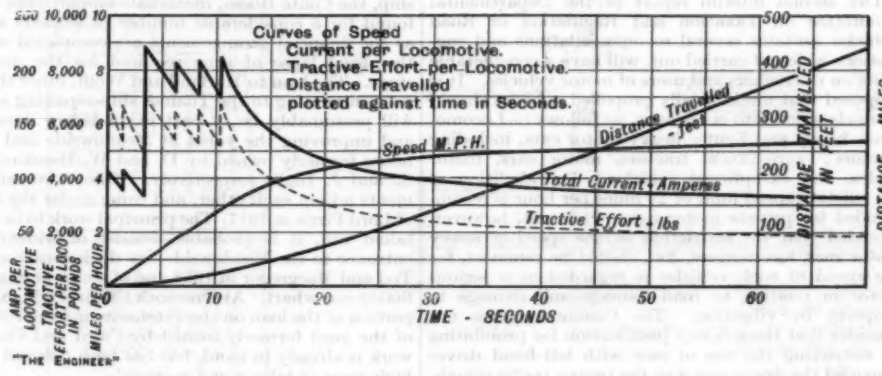


FIG. 4

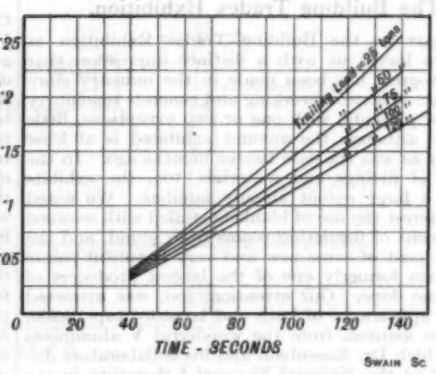


FIG. 5

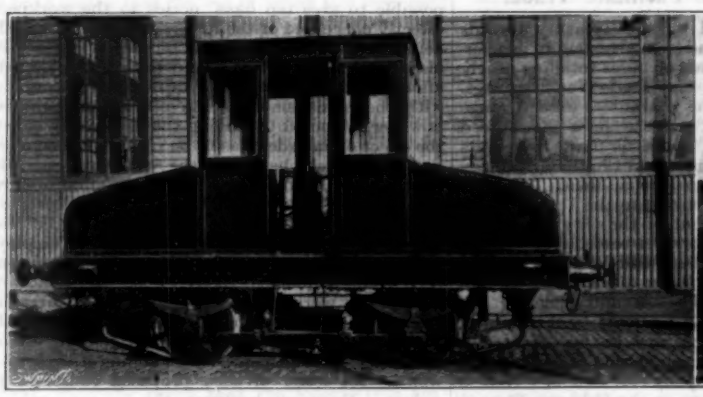


FIG. 6—GENERAL SERVICE BATTERY LOCOMOTIVE

FIG. 7—SPECIAL DUTY BATTERY LOCOMOTIVE

The demands of the market for battery locomotives have until recently been met by engines specially built to conform with a definite schedule of duties, and two engines of this kind are shown in Figs. 6 and 7, the former being of particular interest on account of the fact that it is very similar to the type of machine which has now been selected as the most suitable type for general service. The engine shown in Fig. 7, however, is essentially a special duty machine and was built for handling comparatively small loads without the aid of trucks. The cab of the engine, shown in Fig. 6, is placed centrally on the deck and the battery is housed in two separate compartments having sloping covers and being situated at opposite ends of the locomotive. When fully equipped and ready for service the total weight of the engine is between 14 and 15 tons, and as both axles are driven by the motors this weight is available for adhesion. The electrical equipment is of the standard railway type and is capable of exerting a maximum tractive effort at the wheels of 5000.

The motors, which are of the totally enclosed railway type, are insulated for working at a pressure up to 500 volts and are arranged for comparatively

slow-speed running on the battery voltage. The rating of each motor when working with a pressure of 300 volts is 22 horse-power for one hour with a temperature rise not exceeding 75 deg. Cent. The "Ironclad Exide" battery, made by the Chloride Electrical Storage Company, has a capacity of 226 ampère-hours and is composed of 160 cells. The average discharge pressure is therefore about 300 volts. The maximum trailing load which the locomotive is capable of hauling on a level track is 100 tons, and the battery capacity is such that the radius of action on a level track with the maximum load of 100 tons is about 10 miles at a speed of 6.5 miles per hour. When operating under the usual conditions prevailing in shunting yards the locomotive is capable of hauling a load of 100 tons for a period of about four hours at an average shunting speed of 2 miles per hour.

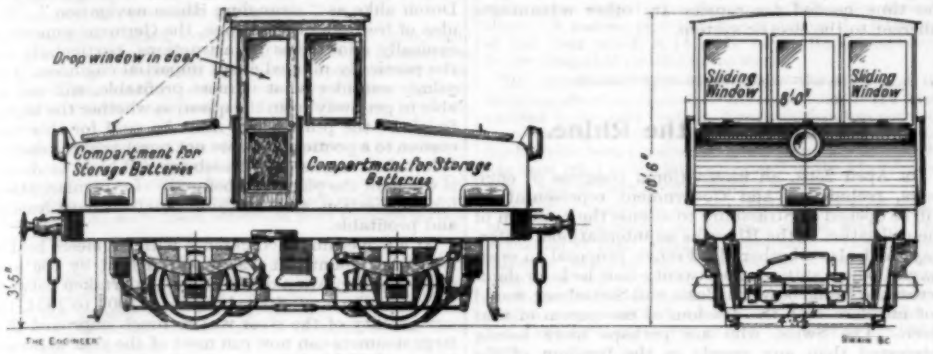


FIG. 8—SINGLE-TRUCK BATTERY LOCOMOTIVE

with keeps and are securely fastened to the side channels of the underframes by bolts and angles. A longitudinal stay of strong section is also riveted to the lower end of the horn plates. The brake is applied by a hand wheel and screw working in a vertical pillar placed in a convenient position in the cab, and the gear is designed so that all the brake blocks are subjected to an equal pressure. Pedal-operated sand boxes are provided at both ends of the locomotive, and they are arranged so that sand may be ejected in front of the leading pair of wheels when the engine is running in either direction. Inside the battery compartments, which are weather proof and painted with acid-resisting paint, a strong channel section fender or carrier is riveted so that the cells are securely wedged in place and made immovable. A hinged lid is fitted to the top of the battery compartments so that the cells can easily be inspected and ample air spaces for ventilation are allowed between the top of the compartment and the lids, which are operated by a small winch in the cab and are securely fastened in both the open and shut positions by means of catches. Hoods are also provided at the ends and sides of the compartments, and these hoods serve as air inlets and help to provide adequate ventilation. The cab is entirely enclosed and is fitted with large fixed and sliding windows at the front and back. Entrance doors with drop windows are also provided. The motors are supported on one side by bearings on the axle and at the other side by a cross bar supported at the ends by helical springs, which absorb both the upward and downward torque.

The general construction and detail work of the double-bogie engine shown in Fig. 9 are very similar to that of the four-wheeled engine just described. The height and width are about the same in both cases, but the length over the buffers of the double-bogie locomotive exceeds that of the four-wheeled engine by about 10ft. 6in. In order to shorten the total length as much as possible the bogie wheel base has been reduced to 6ft. and the pivot centres to 12ft. 6in., with the result that the locomotive will negotiate very sharp curves. A small winch inside the driver's cab serves for opening the lids of the battery compartments in the manner previously described. The sand boxes, which are placed at the ends of the upper structure, have outlet pipes which discharge into deep trays attached to the ends of the bogie frames, which are wide enough to allow for the necessary side play of the bogie, and from these trays the sand falls direct on to the rails. The bogie frames are built up of channels and have steel horn plates, which are fastened and stayed in the same way as those on the four-wheeled locomotive. From the upper structure the weight is transmitted to the bogie through centre pivots, which engage in corresponding centres fastened to the top stays of the bogies. Side bearers are also provided in order to prevent excessive swaying and to obtain steady running. The brake, which is applied by a hand wheel, is provided with balance beams, so that the force is applied to both bogies simultaneously and an equal pressure is exerted on all the blocks. On locomotives intended to work on narrow-gauge railways and on which the draw-bar is placed at a lower level than that shown, it is sometimes necessary, on account of the large bending stresses placed on the underframes, to attach the buffers, &c., to the end beams. In this case all the stresses and shocks are passed through the bogie structure, and some form of connection must be provided which will allow the bogies to be free to move on curves, &c., and to relieve the upper framing from all stresses due to buffing, &c., and if an articulating centre is fitted between the inner ends of the bogies, arrangements must be made to allow one of the centres to slide longitudinally in order that the two bogies may accommodate themselves freely on the curves.

It is necessary when considering the question of what class of electrical equipment should be employed on locomotives of this sort to take into consideration a number of factors, such, for example, as the rough handling which is usual in average industrial shunting yards. It is also to be remembered that continuous operation is demanded for long periods, that the locomotive should be able to start with suitable acceleration, with any trailing load, up to the maximum load which the locomotive is designed to haul, and that curves of small radius have to be negotiated. Standard tramway equipments give tractive efforts which are suitable for average shunting yard service, and since many years of experience has been gained in the design and construction of these equipments, it has been found to be desirable to use them on these

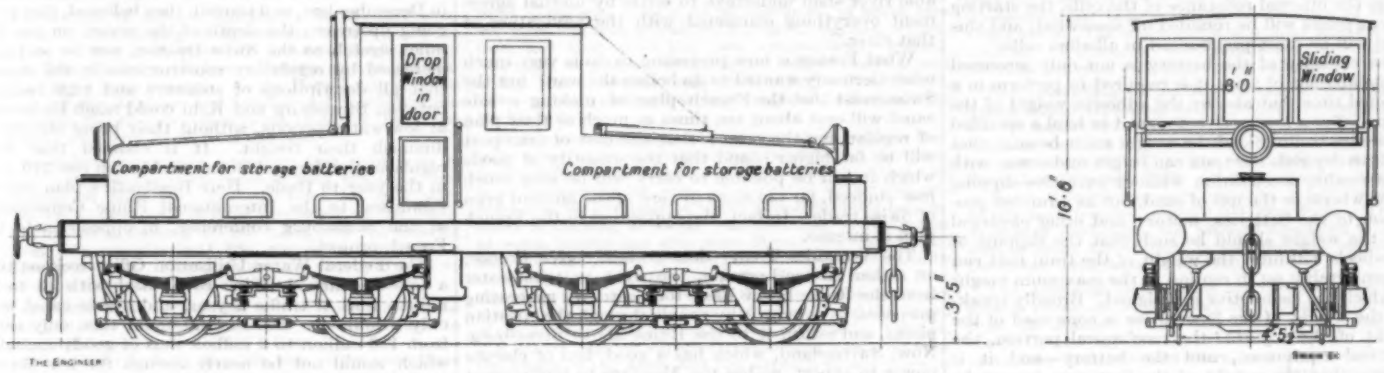


FIG. 9—BOGIE TYPE BATTERY LOCOMOTIVE

The leading dimensions of these locomotives are as follows :—

Gauge (British standard)	4ft. 8½in.
Wheel base	7ft. 6in.
Wheel diameter	2ft. 9in.
Length over buffers	20ft.
Width of footplate	7ft. 9in.
Height from rail to cab top	10ft. 10in.
Tractive effort, 1 hour rating	2500 lb.
Speed	6 m.p.h.

Since these battery locomotives were first introduced the demands of the market have become standardised, and it has been found that in these days two types are sufficient to meet the various haulage requirements. Drawings of these engines are shown in Figs. 8 and 9, and the leading dimensions are given in the following table :—

	Single truck.	Bogie.
Extreme width	8ft.	8ft.
Gauge	Metre to 4ft. 8½in.	Metre to 4ft. 8½in.
Bogie centres	—	13ft.
Wheel base	6ft. 9in.	6ft.
Wheel diameter	33in.	33in.
Length over buffers	18ft. 6in.	29ft.
Height from rail	10ft. 6in.	10ft. 6in.
Weight	14 tons	28 tons
Tractive effort—		
Maximum	8,000 lb.	16,200 lb.
One hour	3,500 lb.	7,000 lb.
Continuous	1,600 lb.	3,200 lb.
Battery capacity, kilowatt-hours	48	106
Average discharge voltage	300	300
Speed at one hour rating of motors at average voltage	4 m.p.h.	4 m.p.h.

The truck framing is in each case strongly built of plates and angles, and channels form the main members of the structure. The end beams are also composed of channels, which are securely stayed with gussets and angles so as to enable them to withstand the heavy shocks which are received in shunting service. Side buffers and centre draw hooks with chains are fitted to the end beams. All the wheels have rolled steel tires, which are shrunk on and are fitted with retaining screws in accordance with standard locomotive practice. The axle-boxes are fitted with lids in order that the bearings may be properly lubricated and examined, whilst the laminated springs which are fitted with links and brackets are placed on top of the axle-boxes. The horn plates are fitted

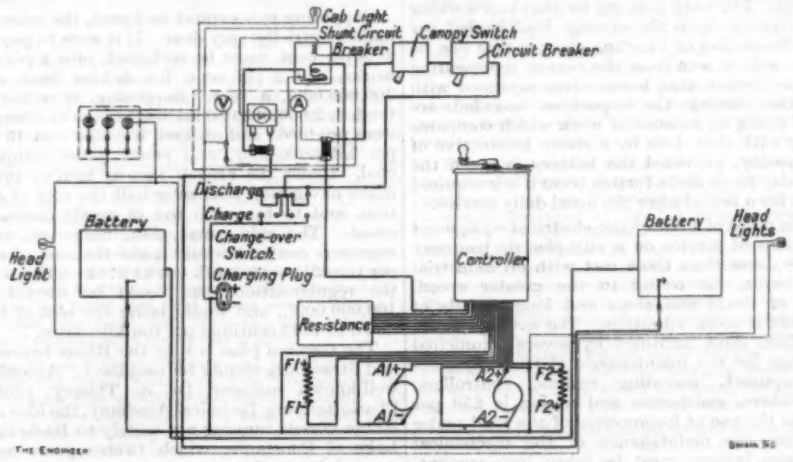


FIG. 10—ARRANGEMENT OF POWER CIRCUITS

battery locomotives. In the case of the engine shown in Fig. 8 two standard tramway motors are used, whilst the double-bogie engine shown in Fig. 9 is fitted with four of these motors. Standard tramway control gear is also employed, but as it is only necessary with locomotives of these dimension to have one driving position, only one controller is employed. As the cab is glazed on all sides and as the driver stands in the centre of the engine, he is able to obtain a clear view of the area in which he is working.

The electrical equipment is of very substantial design and long and severe tests are said to have shown that it is quite capable of withstanding the rough treatment which it is likely to receive in shunting yards. The external dimensions of the motors are such that the machines can be accommodated in a reasonably small space, with the result that the wheel base can be kept within the limits imposed by the track. The storage battery may be composed of lead or nickel alkali cells, the number of cells being sufficient to give an average pressure during discharge of 300 volts. The characteristics of the standard tramway motor designed for slow-speed operation are shown by the curves, Fig. 3, where the speed curves with various starting resistances in circuit are also shown. The controller used for the single-truck locomotive is a series parallel drum type controller with rheostatic braking notches. The controller employed on the bogie locomotive is of similar design, but it is of course, constructed for quadruple equipment and for a greater capacity.

The arrangement of the power circuits is shown in Fig. 10. The negative side of the power circuit is insulated from earth and the positive and negative poles of the battery are protected by fuses. Owing to the manner in which the starting resistance is stepped a steady acceleration is secured and dangerous rushes of current are avoided. The curves, Fig. 4, relate to the starting conditions for the single-truck locomotive. These curves are plotted on the basis of average voltage, but as in actual practice this voltage will fall with a rise in current due to the increase drop across the internal resistance of the cells, the starting current peaks will be rounded off somewhat, and this effect will be most pronounced in alkaline cells.

The capacity of the battery is not only governed by the amount of work it is required to perform in a specified time, but also by the adhesive weight of the engine. For a locomotive designed to haul a specified maximum trailing load the weight must be such that on clean dry rails the train can be got under way with a reasonable acceleration without excessive slipping at the wheels or the use of sand, but as a further protection to the batteries, motors, and other electrical gear the weight should be such that the slipping of the wheels will limit the weight of the train that can be comfortably set in motion to the maximum weight for which the locomotive is designed. Broadly speaking, the weight of the locomotive is composed of the weight of three parts—the mechanical portion, the electrical equipment, and the battery—and it is obvious that the weight of the first part cannot be reduced below the limit which is consistent with the strength necessary to deal with the forces, weights and rough usage of the average shunting service, whilst the weight of the electrical equipment depends to a large extent upon the maximum tractive effort required. Thus the weight of the battery is limited to the difference between the required adhesive weight and the sum of the weights of the electrical equipment, and that of the mechanical parts. The choice of a battery is therefore governed by the watt-hour capacity per unit weight, as against strength and reliability and also against the life of the battery, which is approximately proportional to the weight of the plates. The work that can be done in a working day is dependent upon the average load hauled per trip, and the number of boosting charges that can be given. It will be seen from the curves representing energy consumption that locomotives equipped with the batteries having the capacities specified are capable of doing an amount of work which compares favourably with that done by a steam locomotive of similar capacity, provided the battery is given the usual mid-day boost and a further boost if it is required to do work for a period after the usual daily service.

From the point of view of the electrical equipment the conditions of service on a city electric tramway system are worse than those met with on industrial shunting yards, for owing to the greater speed, frequency of starts and stops and long periods of service there is more vibration. The average figure obtained from data furnished by several municipal undertakings for the maintenance of tramway electrical equipment, including motors, controllers, circuit breakers, resistances and wiring is £50 per annum. In the use of locomotives of the kind under consideration the maintenance of the mechanical structure and battery must be taken into account, but the cost of the former is extremely low. As regards the battery, makers of both the lead and nickel-iron type of cells are prepared to guarantee satisfactory working for a number of years, and depreciation can be calculated as a definite annual proportion of the original value of the battery less a similar proportion of the scrap value.

When the above costs are compared with the cost of renewals and labour involved in the upkeep of the boiler and engine of a steam locomotive and the extra hours which the locomotive men must spend in raising steam and in boiler cleaning, the battery locomotive will, the makers contend, show a considerable saving. Apart from the financial advantage, there are also other benefits to be derived from electric traction and they are in some instances of great importance. The absence of stray sparks, for example, reduces the risk of fire. The electric locomotive is also ready for service at a moment's notice, and as the motors provide a steady torque it is able to start a greater load than the steam locomotive per ton of adhesive weight. Simplicity of operation and the saving in the time needed for repairs are other advantages inherent to the electric system.

Regularising the Rhine.

On April 25th, an international congress of engineers, technicians and Government representatives will be opened at Strassburg to discuss the question of the utilisation of the Rhine as an international waterway, and also whether the French proposal to erect several power stations and twenty-four locks or dams across the Rhine between Basle and Strassburg would not interfere with the freedom of navigation of that river. The Swiss, who are perhaps more keenly interested than any people in the freedom of the Rhine, contend that, according to Article 5 of the Paris Treaty of May 30th, 1814, navigation of the Rhine should be free to all Powers. This article stipulates that: "Navigation on the Rhine, from the point where it becomes navigable unto the sea, and *vice versâ*, shall be free, and in such a way that it cannot be forbidden to anyone." Switzerland also bases her claim to free navigation of the Rhine on the international rules of the Vienna Congress of 1815, concerning the Rhine and its tributaries. Article 108 of this document states that: "The Powers whose territories are separated by one and the same navigable river shall undertake to settle by mutual agreement everything connected with the navigation of that river."

What France is now proposing to do is very much what Germany wanted to do before the war; but the Swiss insist that the French plan of making a side canal will cost about ten times as much as their plan of regularising the river; that the cost of transport will be far higher; and that the quantity of goods which it will be possible to carry will be very much less—indeed, far too small in view of the amount even of Swiss trade. In fact, the opposition to the French plan is intense.

The Versailles Treaty does certainly give France, or rather Alsace-Lorraine, the right to take water from the Rhine below Basle for electricity generating purposes, to convey it by canals through the Alsatian plains, and return it to the Rhine above Strassburg. Now, Switzerland, which has a good deal of electric power to export, wishes the Alsatians to buy current from her, instead of generating it themselves. This current, she contends, she could supply more cheaply than it could be produced in Alsace. According to Swiss experts, the net cost of all the works (side canal, locks, &c.) proposed by the French between Basle and Strassburg would be the following:—

	Francs.
For a side canal	600,000,000
For barrages and hydro-electric works ..	1,000,000,000
For navigation works (reinforced locks 250 m. by 23 m., ordinary locks 90 m. by 22 m., and docks for passing and heaving-to every 5 kilom.)	600,000,000
Total	2,200,000,000

Supposing this capital be found, the scheme would make electricity very dear. If it were to pay, interest at 8 per cent. must be reckoned, plus 4 per cent. for works, and 2 per cent. for sinking fund, or nearly 300,000,000f. a year. Supposing, it is further contended, 2,000,000,000 kilowatt-hours of electric power were produced and utilised, it would cost 15 centimes per kilowatt-hour, and could never compete with coal. Hence the French factory owners propose to make navigation bear over half the cost of construction, and to tax each ton of goods carried on the canal. The side canal plan, moreover, the Swiss engineers contend, would make the cost of transport per ton-kilometre work out at 8.64 centimes, whereas the regularisation plan could be carried out for 100,000,000f., and would bring the cost of transport down to 1.43 centimes per ton-kilometre.

The German plan is that the Rhine between Basle and Strassburg should be canalised. According to a well-known engineer, Dr. de Thierry, professor at Charlottenburg Technical Academy, the idea of having Rhine vessels running not merely to Basle but to the Lake of Constance, which twelve years ago or so seemed impossible, is now considered feasible, and, in fact, can now be proved to be not merely a possible but a thoroughly sound undertaking, especially if the Lake of Constance can be made to store up large quantities of water for periods of drought and water scarcity. The question is now, the Germans say, not whether it is possible to utilise the Rhine, but merely how it can best be done. The Basle-Constance part of the river, says Dr. de Thierry, must be canalised. That would mean erecting weirs in order to have the falls necessary for obtaining the large amount of water power required. Thus the preliminary conditions for navigation would be created. The weirs would prevent the water from flowing away so fast, and the decreased speed of the river would render navigation possible. By blocking the water at the weirs the cost of tugs would also be lessened, because they would not need to use so much force. For navigation, so the German experts claim, there is a great difference between a canalised and a regularised river Rhine as regards the way the fall is overcome. The idea of a side canal, or a "Grand Canal d'Alsace," as the French call it, is described by the Germans, Swiss and Dutch alike as "strangling Rhine navigation." The idea of freedom of the Rhine, the Germans somewhat cynically admit, has its attractions, particularly for the poetically minded; but impartial engineers, who calmly consider what is most profitable, will not be able to get away from the question whether the higher freights—the price which must be paid for this concession to a poetic ideal—are not purchased too dearly. What the congress at Strassburg will have to decide is which of the plans laid before it—for regularisation, for canalisation, and for a side canal—is most feasible and profitable.

At a Government conference with engineers held in Berne last month, it was reported that by the low-water regularisation of the Rhine undertaken between Sondernheim and Strassburg from 1907 to 1914, the navigability of the river was so much improved that large steamers can now run most of the year to Strassburg and Kehl (just opposite Strassburg, in Baden). Dams were formed in the current of the stream, and they forced the low water into a so-called "low-water river bed," which made it possible to run vessels even when the river was low. The low-water bed can be prevented from varying much by ground sills being laid in the bed of the stream, which the Baden people officially estimate will cost 160,000 marks per river kilometre, or 13,600,000 marks altogether—pre-war prices.

The Federal Water Utilisation Office in Switzerland and a leading Swiss engineer, Herr Bosshardt, reported to the International Rhine Navigation Commission in December last, and proved, they believed, that even going upstream, the depth of the water, on the 77½ miles stretch to the Swiss frontier, can be so much increased by regulatory constructions in the stream that all descriptions of steamers and tugs running between Strassburg and Kehl could reach Basle even at low-water periods, without their being obliged to diminish their freight. It is claimed that with regularisation large steamers could even run 320 days in the year to Basle. Herr Bosshardt's plan will be submitted to the International Rhine Commission, at the Strasburg conference, in opposition to the French project.

The Federal Water Utilisation Office reckons that a free regularised Rhine could deal with 13 to 20 million tons of traffic a year, and a side canal with only 3 millions. Switzerland could then only carry from 1.6 million to 2 million tons of goods annually, which would not be nearly enough for her normal trade requirements. In the Swiss commercial world, and in the country in general, it is felt that an outlet to the sea is absolutely necessary, and there are those who maintain that that outlet can only be by way of the Rhine.

According to the Board of Trade returns the value of the railway material exported during January and February of the present year was as follows, the corresponding figures for 1921 and 1920 being added in parenthesis:—Locomotives, £1,435,859 (£1,107,915, £477,919); rails, £656,589 (£888,929, £197,181); carriages, £231,004 (£215,165, £214,702); wagons, £1,064,409 (£949,057, £851,831); wheels and axles, £246,027 (£393,487, £282,239); tires and axles, £117,115 (£294,431, £205,251); chairs and metal sleepers, £378,060 (£359,554, £58,567); miscellaneous permanent way, £312,147 (£521,019, £312,890); total permanent way, £1,709,938 (£2,457,420, £1,065,694). Locomotives to the value of £220,870 were, during February, shipped to Europe and of £161,230 to India. Rails to the value of £47,765 were shipped to the Argentine, and of £32,598 to India.

At the valedictory meeting of the shareholders of the Lancashire and Yorkshire Railway the chairman said that the company had always been in the front rank so far as improvements were concerned. It was the first to adopt numbered cardboard tickets, before which the names of all passengers were written on paper tickets by the booking clerks. The principle of numbered tickets had been submitted to and rejected by other railway companies. The company was the first to fit the rolling stock with continuous brakes; the first to install the block system of signalling throughout the main line; and also, he believed, that the section through Summit Tunnel, near Littleborough, was the first portion of any railway ever worked on the block system by the electric telegraph. It was the first company to light its trains with gas, and the first to complete the equipment of passenger stock with automatic continuous brakes; the first to equip goods engines with continuous brakes; the first to install telephones in signal boxes; the first to fit the whole of its wagon stock with either-side brakes; the first to provide smoking compartments; and the first to bring into use electric traction with its own generating station, on the line between Liverpool and Southport. It had also taken a lead in the "rationing" of extension tickets to pleasure resorts. Mr. Fielden's reference to the block system is, we think, not quite accurate. The first block system installed was in 1844 on the Norfolk Railway, and the first company to adopt the block system throughout was the London, Chatham and Dover, which in 1874 had the whole of its line equipped.

Railway Matters.

The Highland Railway Company has now twenty-one more engines than in 1913, but owing to the eight hours' day the use of all of them is required to work the same amount of traffic.

In the Taff Vale Company's annual report for 1921 there appears an entry in the Capital Expended Account of £48,918 for five tank 0–6–2 locomotives. A charge against capital of £2470 is made for converting four rail motor cars into passenger coaches.

Locomotive spark arresters have recently been mentioned in Parliament, and Mr. Neal said that his information was that no completely satisfactory spark arrester for railway locomotives which does not militate against draught and does not increase firing difficulties has been devised.

None of the 150 crores of rupees proposed to be spent by the Indian Government during the next five years is to be on new railways. Earl Winterton said on the 6th inst. that there was no prospect of any appreciable new mileage being undertaken otherwise than through private enterprise.

Work is progressing on the extension of the Canadian Pacific line from Kipawa to Les Quinze, at the further end of Lake Temiskaming, 800 men being employed. The line penetrates a fine agricultural area in which, however, there are still thousands of acres of rich land awaiting settlement.

The Inter-state Commerce Commission has just opened an investigation to determine whether, and to what extent, power brakes now in general use are adequate and in accordance with requirements of safety, what improved appliances or devices are available for use, and what improvements may or should be made.

Constant trouble is experienced in the United States owing to floods and storms breaking down the telegraph lines belonging to the railway companies. The Nashville, Chattanooga and St. Louis intends to meet this difficulty by employing wireless telegraphy, and it has installed stations at Tullahoma and Guntersville, which will be followed by one at the general offices at Nashville and the various divisional headquarters.

An example of what is apparently unnecessary competition is the running of an express from Victoria to Fratton without a stop by the London, Brighton and South Coast Railway. It leaves Victoria at 1.35 and consists of three bogie coaches. As the Portsmouth traffic is pooled by the Brighton and London and South-Western companies, this train is evidently run to enable the former company to justify its share of the pool.

The railway companies announce that reductions in railway rates for the conveyance of milk will come into operation on May 1st. Railway rates for milk vary according to distance. A large proportion of the traffic is carried for a distance of 100 miles, and the existing railway rate amounts to 1.82d. per gallon, or under a halfpenny a quart. Empty churns are conveyed back to the station where the traffic originated free of charge.

The North-Eastern chairman said at the recent annual meeting of that company that there was no occasion to paint a picture of unrelieved gloom. During recent months, and particularly since the turn of the year, there had been a distinct and most welcome revival in the carriage of coal for shipment, whilst agricultural traffic showed a surprising vitality in spite of the grave disadvantages under which agriculture was then carried on.

The City of Dublin Steam Packet Company is promoting a Bill to wind itself up. As it is a guarantor, along with the Great Northern (Ireland) and the Dublin and South-Eastern, of the 4 per cent. guaranteed stock of the City of Dublin Junction Railway, by which the Kingstown mail trains get to and from the Great Northern, Great Southern and Western and the Midland Great Western railways, its co-guarantors are anxious as to their future responsibility. A parliamentary Committee has reported against the Bill.

The total freight tonnage for December, 1921, when compared with the corresponding period of 1920, decreased 14.8 per cent. and the ton-mileage 15.6 per cent. General merchandise decreased 17.2 per cent. in tonnage and 14.1 per cent. in ton-miles; coal, coke and patent fuel decreased 6.1 per cent. in tonnage and 9.0 per cent. in ton-miles, whilst other minerals decreased 39.6 per cent. in tonnage and 38.0 per cent. in ton-miles. The freight train mileage was reduced by 9.8 per cent. The net ton-miles per engine hour were 420 as compared with 402 in December, 1920, which means that the traffic got over the road more quickly.

A demonstration of what is known as the "carrier current" system of communication was made by the General Electric Company at Schenectady recently. It has been tried, with satisfactory results, on the Chicago, Milwaukee and St. Paul Railroad, and is applicable to all electrically operated lines where there is an overhead power line. A second current, generated at a higher frequency than the power supply, is superimposed on the trolley wire, and serves to transmit messages along the wire to telephones on the trains. The guard and driver can converse with each other, and, where it is particularly useful in the United States, the driver of a long freight train that is being assisted in the rear can speak to the driver of the banking engine.

A few weeks ago President Harding, addressing an agricultural conference in Washington, said that greater attention should be given to the development of inland waterways and to the electrification of railways. His remarks about the latter were:—"A large share of railway tonnage is coal for railway fuel. The experience of railway electrification demonstrates the possibility of reducing this waste and increasing efficiency. We may well begin very soon to consider plans to electrify our railroads. If such a suggestion seems to involve inordinate demands upon our financial and industrial power, it may be replied that three generations ago the suggestion of building 260,000 miles of railways in this country would have been scouted as a financial and industrial impossibility."

Notes and Memoranda.

A loud-speaking wireless telephone installation has just been completed at Lausanne, which will be in communication with the Eiffel Tower telephone each evening, and will be able to record communications from London, Berlin, and even America.

Ships taking oil from the Sarawak wells are supplied through submarine pipes, which carry the oil out to depths which will accommodate the largest vessels. Some of these pipes extend over two and a-half miles from the shore. A marine pipe line placed during the latter part of last year which is 14,555ft. in length, is supposed to be the longest of its kind in the world.

By introducing heat rapidly into the coal, and thus bringing about an immediate decomposition of the hydrocarbons in the cold coal, an American firm has succeeded in producing metallurgical coke from Illinois coal which has hitherto been considered non-coking. The new product has been tried in the laboratory and in the blast-furnace, and is said to have given excellent results.

What is described as probably the thickest seam of black coal discovered in any part of the world is being developed at Blair Athol, in Queensland. The maximum thickness, as far as can be ascertained, is 93ft. The whole seam from top to bottom is quite free from clay bands. Professor David, of the Sydney University, describes the coal as very suitable for raising steam on both land and sea. His estimate of the coal in the field is 258,000,000 tons.

The presence of aluminium oxide in the metal or in its alloys seems to lead to defects of various kinds, and the problem is under consideration for study in the United States with a view to obtaining, if possible, a commercial deoxidiser. Preliminary experiments have been made with the use of misch metal (ferrocerium), and with boron suboxide for the deoxidation of aluminium-copper alloys. The former material appears to possess some possibilities, and further experiments are to be made.

Figures showing the work done up to the end of 1921 towards the reconstruction of the war-damaged mines in the Departments of the Nord and the Pas de Calais have just been published. Up to the present over 60,000,000 cubic yards of water have been pumped out, over 1800 miles of galleries have to be reconstructed, of which over 600 miles had been abandoned during the German occupation, and 1350 miles had been systematically flooded. Work can only be carried on at the rate of about a yard a day, and sometimes only half a yard. Everywhere, however, coal getting has been resumed in some of the working places.

It is a common impression among wood-workers that wood which in breaking shows long splinters has, therefore, longer fibres than material which breaks off short, but this is not necessarily the case. A sample of timber recently submitted for examination to the Forest Products Laboratories of Canada, Montreal, was described by the sender as weak, brashy and with short fibres. On examination with the microscope, however, the fibres were found to be unusually long for that particular kind of wood. It is stated by the laboratories that there is in fact no known relationship between the length of splinters and the length of the fibres or cells of which wood is composed. Further, it is stated that no apparent relationship exists between the length of the fibres and the strength of any piece or kind of wood.

According to a note in *Indian Engineering*, the report of the committee of engineers appointed by the Government of Bengal to advise with regard to the erection of a new bridge over the Hooghly River, recommends the cantilever or large span type of bridge, and the cost is estimated at two million pounds sterling, while it is expected that about three and a-half years will be occupied in its construction. The new bridge, it is suggested, should be built on a site on a centre line running from a point 630ft. north of the centre of the existing bridge, on the Calcutta side, to a point 580ft. north of the centre on the Howrah side. Provision has been made for three lines of vehicular traffic each way in addition to two lines of tramways. The total width of the bridge is recommended at 100ft., allowing 18ft. for two lines of tramways, 58ft. for six lines of traffic, and 24ft. for two footpaths.

Lecturing on the subject of electric steel furnaces before the West Yorkshire Metallurgical Society, Mr. F. Rowlinson said that chemical guidance was absent when tool steel first began to be manufactured, and but little was needed to-day. Where no impurities went in, no chemical means were necessary to take them out again. The materials used by the steel makers comprised the best steel-making Swedish irons, the best Sheffield blister bar, every piece hand-fractured and graded, the best Swedish white irons, and the best Sheffield tool scrap. All these materials, of unsurpassed purity and quality, were chosen, and no others. The best crucible steel to-day was still made from the materials chosen more than a hundred years ago. The crucible steel industry had been called conservative and apathetic, but the fact still remained that to this day the finest tool steel in the world, Sheffield's crucible steel, was made only from the most expensive materials of unquestioned purity and quality.

In a paper on "Coast Erosion and its Prevention," read before the Royal Society of Arts, Professor E. R. Matthews states that many devices for the prevention of erosion have been introduced, but most of them have proved a failure. Floating breakwaters anchored to the shore, large rocks, and in some cases huge blocks of concrete, specially arranged on the foreshore, with a view to breaking the force of the waves, have been tried with the object of protecting the shore, but most of them have created a scour and have done much damage instead of good. Rows of piles have sometimes been driven parallel with the shore and a few feet seaward of the cliffs or sea wall, but they have been quite unsuccessful. Dr. Owens suggests that shore protection works might be divided into active and passive types; the former comprising groynes and such structures as attempt to do something more than merely resist attack, and the latter including sea walls and embankments, which only attempt to substitute a harder and more durable material for a softer.

Miscellanea.

The coal output at the mines of Great Britain for the week ended April 1st was 4,825,400 tons, as compared with 4,929,300 in the previous week, and 1,950,100 tons in the week ended April 2nd, 1921.

After considerable competition, the contract for lighting the grounds of the Brazilian Centennial Exhibition has been awarded to the American General Electric Company, the estimated cost being 1,000,000 dols. (£200,000).

We are informed that the site allotted for the British building in the International Exhibition at Rio de Janeiro which is to be opened on September 7th next, is one of the best in the whole exhibition, and the work in its construction is well in advance of that done by other nations.

An official start was made with the Newark sewerage scheme on March 30th, the mayor cutting the first sod. The scheme has now passed the Ministry of Health, subject to details, and a grant obtained of 65 per cent. of the interest on £25,000 for fifteen years. The scheme is estimated to cost £55,000.

The Anglo-Indian Press reports that Government assistance is being given to an Indian firm which is erecting a plant for the refining of glycerine as a by-product of soap manufacture. The glycerine, it is hoped, will be utilised in the manufacture of dynamite, and will effect a considerable saving in the expenditure on ordnance.

Owing to the increase in the consumption of gas, the Colombo Gas Company has applied for permission to the City Corporation to allow it to install a new gas plant to manufacture water gas. In the meantime it proposes putting up an extra plant and also a new gasholder at Havelock Town to supply gas to that part of the city.

Edinburgh Town Council recently set aside recommendations by the Tramway Committee of the Council that car rails should be obtained from Germany. The German offer was considerably lower than the British offers. The Council resolved to accept the lowest British tender, the principal argument advanced being that it would help trade in this country.

A deposit of iron ore is said to have been discovered by the Hendy Hematite Iron Ore Company at Pontyclun, near the Great Western and Taff Vale Railways, where prospecting has been going on for upwards of two and a-half years. The construction of a short length of tramroad will be proceeded with immediately to connect the outlet of the mine with the railway sidings.

The production of pig iron in the United Kingdom during March amounted to 389,800 tons, compared with 300,100 tons in February and 386,000 tons in March, 1921. Furnaces in blast at the end of March numbered 107, compared with 109 before the coal stoppage and 101 at the end of February, 1922. Of the production of pig iron in March, 149,300 tons were hematite, 113,000 tons basic, 86,000 tons foundry, and 20,100 tons forge. The production of steel ingots and castings amounted to 549,400 tons, a figure higher than in any previous month since December, 1920, when it was 746,000 tons.

The Argentine Government has decided to decline all outside offers—of which many have been submitted—to clear the channel of the river Plate of the number of vessels (exceeding fifteen) which during the past few years have been wrecked there, and which constitute a continual danger to navigation. British engineering firms and contractors, as well as several foreign speculators, have made proposals at various periods to purchase the wrecks from the Government and to dynamite the hulls with a view to disposing of the various materials salved. These plans have also been rejected by the Government, which, through the Ministry of Marine, will carry out the work on its own account, the Public Works Department furnishing all necessary dredgers and flat-boats.

Addressing the members of the Birmingham and District Electric Club recently on the progress made during the war in the method of salvaging sunken vessels by means of electrical apparatus, Mr. V. H. Pearson gave as an example the transport Admiral Cochrane, which was torpedoed by a German submarine off the South Coast of England. In this case the vessel had taken on a list of 33 deg., the whole of the after decks being submerged. It would have been impossible to salve the ship by means of steam pumps owing to the degree of list. The electric pump could, however, be lowered into the hold of the ship and could be kept running under water. The transport was lifted within seven days and placed on an even keel on the beach. After slight repairs in dry dock the vessel was put into commission again.

The state of the Swiss machine industry, states a Government report, is portrayed by the state of unemployment. At the beginning of 1920 there were 53,575 workmen employed by the 178 firms forming the Union of Swiss Machine Manufacturers. On November 21st, 1921, 13,000 of these had been dismissed. Of the remaining 40,000, only about 18,000 are fully employed, whilst the remainder are working reduced hours to the extent of 30 to 50 per cent. In consequence of the high rate of exchange of the Swiss franc, exports are greatly reduced, whilst French locomotive orders have ceased, owing to the need of keeping French works occupied. Switzerland's severest competitor, namely, Germany, is able to undersell Swiss manufacturers by 70 per cent., owing to the high internal purchasing power of the mark.

The Paris *L'Information* learns that the Baltic-Black Sea Syndicate has conceived the idea of constructing a coal canal between Dantzig and Silesia. The authors of the project consider that the Polish riverways will constitute an important factor in the development of commerce between the East and West. The canal would require eight years to construct, and would cost 350 million gold francs. It would serve forty important towns and cross a mining and an industrial region, with branches to Posen and Warsaw. The goods to be transported would be principally coal, peat, timber, potatoes, grain, beetroot, iron ore and building materials. The canal would, it is anticipated, be of great importance in connection with the reconstruction of Russia, as it would provide a direct outlet to the markets of Southern Russia and Central Asia.

CONCRETE TRUSS BRIDGE OVER THE WICHITA RIVER, TEXAS

MR. T. V. JENKINS, DENVER, COL., ENGINEER

(For description see page 436)

FIG. 1—REINFORCEMENT FOR TRUSSES LAID ON FLOOR OF TRAVELLER

FIG. 2—ONE OF THE 66-FEET CONCRETE TRUSSES BEING RAISED INTO POSITION

FIG. 3—LEFT HAND TRUSS IN POSITION ON PIERS

FIG. 4—LEFT AND RIGHT-HAND TRUSSES IN POSITION AND CROSS GIRDERS COMPLETED

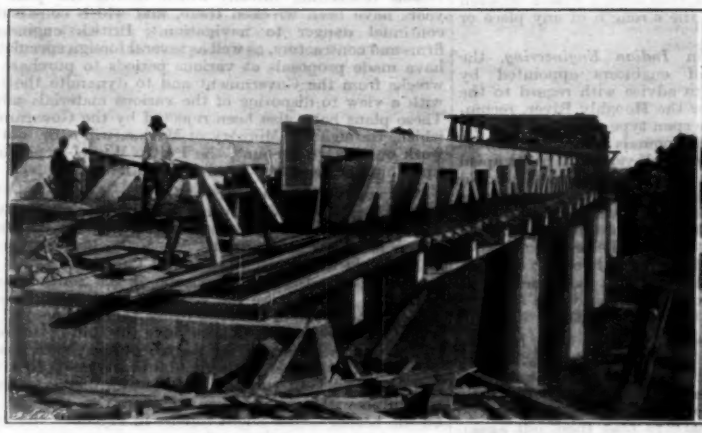


FIG. 5—FLOOR AND OUTSIDE PATHWAY PARTLY COMPLETED

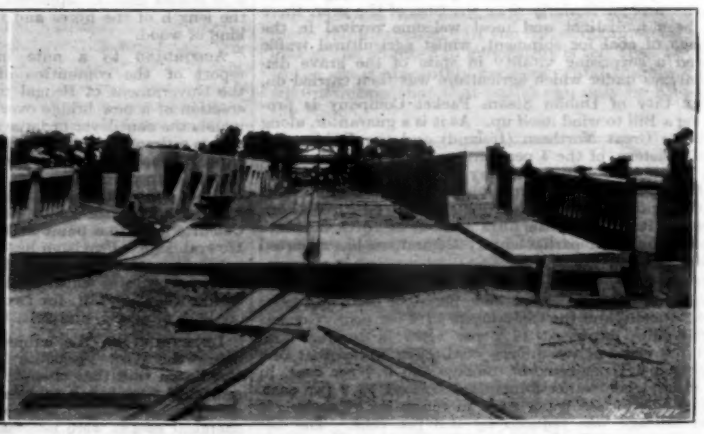


FIG. 6—FINISHED SPAN, WITH TRUSSES, FLOOR AND HAND RAILINGS

FIG. 7—THREE SPANS AT DIFFERENT STAGES OF CONSTRUCTION

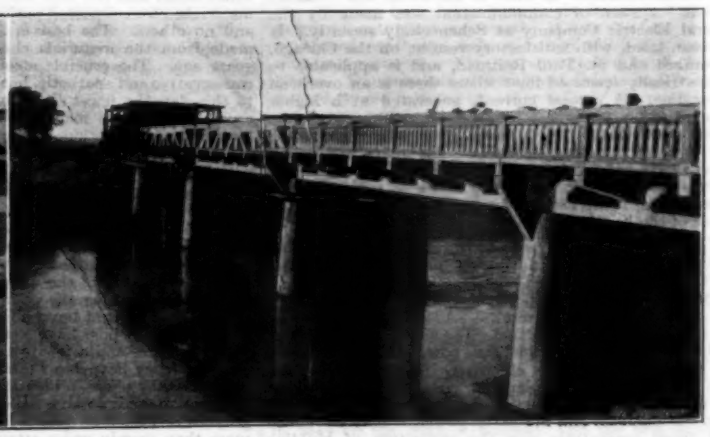


FIG. 8—THE BRIDGE NEARLY COMPLETED

AGENTS ABROAD FOR THE SALE OF

The Engineer

BUENOS AIRES.—MITCHELL'S BOOK STORE, 576, Cangallo.
CHINA.—KELLY AND WALSH, Limited, Shanghai and Hong Kong.
EGYPT.—CAIRO EXPRESS AGENCY, near Shepheard's Hotel Cairo.
FRANCE.—BOYVEAU AND CHEVILLET, Rue de la Banque, Paris. CHAPELOT AND CIE., 136, Bld. St. Germain, Paris.
BELGIUM.—W. H. SMITH AND SON, 78/80, Rue du Marché-aux-Herbes, Bruxelles, and 44, Rue Joseph II., Ostend.
INDIA.—A. I. COMBRIDGE AND CO., Bombay; THACKER AND CO., Limited, Bombay; THACKER, SPINK AND CO., Calcutta.
ITALY.—MAGLIONI AND STRINI, 307, Corso, Rome; FRATELLI TREVES, Corso Umberto 1, 174, Rome; FRATELLI BOCCA, Rome; ULRICO HOEPLI, Milan.
JAPAN.—MARUZEN CO., Tokyo and Yokohama.
AFRICA.—WM. DAWSON AND SONS, Limited, 7, Sea-street (Box 49), Capetown.
C. JUTA AND CO., Johannesburg, East London, and Grahamstown.
AUSTRALIA.—GORDON AND GOTCH, Limited, Melbourne, Sydney, Brisbane, and Perth, &c.
MELVILLE AND MULLEN, Melbourne.
ATKINSON AND CO., Gresham-street, Adelaide.
CANADA.—DAWSON, WM., AND SONS, Limited, 87, Queen-street East, Toronto.
GORDON AND GOTCH, Limited, 132, Bay-street, Toronto.
MONTREAL NEWS CO., 386-388, St. James-street, Montreal.
TORONTO NEWS CO., 42, Yonge-street, Toronto.
CEYLON.—WIJAYARTNA AND CO., Colombo.
JAMAICA.—EDUCATIONAL SUPPLY CO., Kingston.
NEW ZEALAND.—GORDON AND GOTCH, Limited, Wellington and Christchurch; UPTON AND CO., Auckland; J. WILSON CRAIG AND CO., Napier.
STRAITS SETTLEMENTS.—KELLY AND WALSH, Limited, Singapore.
UNITED STATES OF AMERICA.—INTERNATIONAL NEWS CO., 83 and 85, Duane-street, New York; SUBSCRIPTION NEWS CO., Chicago.

Agents Abroad for Advertisements.

UNITED STATES OF AMERICA.—BRITISH AND COLONIAL PRESS, Inc., 736, The Knickerbocker Building, 152, West 42nd-street, New York City.
FRANCE.—AGENCE VOX, 7, Rue de Surène, Paris (VIIIe).
BELGIUM.—W. H. SMITH AND SON, 78/80, Rue du Marché-aux-Herbes, Bruxelles, and 44, Rue Joseph II., Ostend.

SOUTH AMERICAN BRANCH OFFICE OF

The Engineer.

526, Bolsa de Comercio, Buenos Aires.

SUBSCRIPTIONS.

THE ENGINEER can be had, by order, from any newsagent in town or country, at the various railway stations; or it can, if preferred, be supplied direct from this office.
Half-yearly (including index number) .. £1 12s. 6d.
Yearly (including two index numbers) .. £3 5s. 0d.
If credit occur, an extra charge of two shillings and sixpence per annum will be made.

Foreign Subscriptions will be received at the rates given below. Foreign subscribers paying in advance at these rates will receive THE ENGINEER weekly and post free. Subscriptions sent by Post Office Order must be made payable to THE ENGINEER and accompanied by letter of advice to the Publisher.

THIN PAPER COPIES.		THICK PAPER COPIES.	
Half-yearly ..	£1 11s. 6d.	Half-yearly	£1 13s. 9d.
Yearly	£3 3s. 0d.	Yearly	£3 7s. 6d.

(The difference to cover extra postage.)

Canadian Subscriptions—
Thin paper edition .. .. £2 18s. 6d. per annum.
Thick paper edition .. .. £3 3s. 0d. ,,

ADVERTISEMENTS.

*** The charge for Situations Open and Wanted Advertisements of four lines and under is four shillings, and one shilling per line for each additional line up to one inch. When an advertisement measures an inch or more the charge is twelve shillings per inch. The rates for all other classes of advertisements, other than those mentioned above, are included in "THE ENGINEER Directory," which is sent post free on application. All single advertisements from the country must be accompanied by a remittance in payment. Alternate advertisements will be inserted with all practical regularity, but regularity cannot be guaranteed in any such case. All except weekly advertisements are taken subject to this condition.

Small Advertisements cannot be inserted unless delivered before TWO o'clock on Thursday afternoon (the day before publication). ALTERATIONS to STANDING ADVERTISEMENTS must arrive not later than THURSDAY of the week preceding publication.

Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Manager, all other letters to be addressed to the Editor of THE ENGINEER.

Postal Address, 33, Norfolk-street, Strand, W.C. 2.
Teleg. Address, "Engineer Newspaper, Estrand, London."
Telephone Nos. 2256, 2257 Central.

PUBLISHER'S NOTICES.

*** If any Subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

TO CORRESPONDENTS.

*** All letters intended for insertion in* THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.*

By arrangement with Reuter's Engineering Service **The Engineer** *contains the latest news from all parts of the world which is likely to be of interest to engineers.*

Contents.

THE ENGINEER, April 21st, 1922.	PAGE
CHINESE ENGINEERING NOTES	431
THE GERMAN SUBMARINE BUILDING PROGRAMME, 1914–1918. (Illus.)	431
THE INTERNATIONAL RAILWAY ASSOCIATION. No. IV.	434
NEW TYPE OF CONCRETE TRUSS BRIDGE. (Illus.)	436
A SEVEN-DAY JOURNAL	437
BATTERY LOCOMOTIVES FOR INDUSTRIAL SHUNTING YARDS. (Illus.)	438
REGULARISING THE RHINE	440
RAILWAY MATTERS	441
NOTES AND MEMORANDA	441
MISCELLANEA	441
LEADING ARTICLES—	
Industry and Economics	443
Pacific Type Locomotives	444
OBITUARY—	
Isoji Ishiguro	444
INSTITUTION OF NAVAL ARCHITECTS. No. III.	445
LOCOMOTIVE ECONOMY. (Illus.)	446
COTTON RESEARCH	447
DIESEL MACHINERY FOR SINGLE-SCREW MOTOR SHIPS. (Illus.)	448
CATALOGUES	449
SURPLUS ELECTRICAL ENERGY FOR STEAM PRODUCTION. (Illus.)	450
VERTICAL LOG BAND MILL AND CARRIAGE	450
PROVINCIAL LETTERS—	
Midlands and Staffordshire	451
Lancashire	451
Sheffield	452
North of England	452
Scotland	453
Wales and Adjoining Counties	453
INSTITUTION OF MECHANICAL ENGINEERS	453
PERSONAL AND BUSINESS ANNOUNCEMENTS	453
CURRENT PRICES FOR METALS AND FUELS	454
FRENCH ENGINEERING NOTES	455
BRITISH PATENT SPECIFICATIONS. (Illus.)	455
FORTHCOMING ENGAGEMENTS	456

THE ENGINEER.

APRIL 21, 1922.

Industry and Economics.

EVEN when all allowance is made for Lord Weir's leaning towards the economics of industry, it is surely a sign of the times that an eminent engineer should take for the subject of a commemorative lecture on James Watt "Some Aspects of Industry and Economics." There is no lack of technical and scientific matters on which it is well to clear our minds by an annual summary, and there are few, if any, which are not made plainer by a certain amount of historical background. On some of those subjects Lord Weir is competent to speak from his own direct experience, and others he could handle through his unexcelled opportunities for acquiring information from sources-in-chief. What subject, for example, could be more appropriate to a James Watt lecture than condensation? Lord Weir could have presented us with an admirable *résumé* of the progress since the days of Watt's great invention, and could have exhibited clearly the small progress that has been made in a hundred years and more. Such a lecture is required, for with the coming of the steam turbine the importance of condensation has increased greatly, and to-day there is no single subject that has more influence on power-house development than the supply of cooling water. The inventor who can tell us how to maintain a high vacuum with half the present amount of circulating water will confer on the world a benefit not so very much less than that conferred by Watt's primary invention of the separate condenser. These things are well known to Lord Weir. He appreciates as fully as any one the need for technological developments, and yet he devoted his lecture at Greenock on March 24th to industrial and economic problems. That is a striking fact which, as we have had to point out before, shows us the path on which our feet are placed. Our engineers should be spending their lives in the pursuit of that science for which their profession and training fits them. They should be seeking technical improvements in methods of production and in the efficiency of the machines produced. But such is the condition of workshop affairs and so involved and engrossing are the cares and anxieties of business that several hours of each day have to be devoted by the chiefs to questions which have little or nothing to do with technical engineering, whilst the technical work has to be entrusted to subordinates or to the chance progress that may be made by casual inventors. The condition is not a healthy one. Workshop economics has become an obsession with many engineers, and is interfering grievously with the rate of technical development.

This general criticism apart, we find much in Lord Weir's lecture—which is now available in printed form—to interest us. With the lecturer's line of thought engineers are already familiar. His firm was one of the first to adopt, in this country, the premium system of paying wages, and he has always insisted firmly on the necessity for good wages with a low labour cost per piece. But if, after all, the product is too expensive for the market, then, he insists, we must content ourselves with a lower standard of life in order still further to reduce the price. "Our potential customers," he said, "are infinitely poorer than ourselves; many of them are producing on a very much lower standard of living than ourselves; certainly many of our competitors are making heavy sacrifices to obtain markets for their goods. There, therefore, appears to be need for a much more general appreciation of the fact that there can be little confidence or enterprise, little real faith in values, until we, the most stable nation of all, indicate by our domestic policy that we recognise it is not possible for us to exist on an economic plane high above that of both our customers and competitors." There we have the factor which sooner or later settles remuneration of all kinds, be they wages or salaries. We, as a nation, are trying to live as if we were very much richer than purchasing and competing nations. It is impossible; for, on the one hand, the purchasing nations are too poor to pay our present prices, and, on the other, the competing nations—America must be excluded as exceptional—being content to exist on a lower economic plane, can undersell us. The Government, by slow degrees, is being brought to see this elementary fact, the employers see it by compulsion through the falling of dividends, the workpeople must see it too. Work and low wages are better, at least, than no work and no wages. They are trying to live on too high an economic plane. They want short hours and high wages, and only by the pinch of necessity are they beginning to see that the doctrinaires who have brought them by that road to the verge of starvation are blind leaders of the blind. Here is a striking estimate made by Lord Weir. "There are approximately seven millions of trade union workers in this country. Since 1918 their hours of labour have been reduced by approximately 14 per cent. In 1920 they were all employed, let us say, at an average wage of 60s. per week for forty-eight weeks. If they had worked their old hours for the same wages the saving of cost of production on wages alone would have been about 150 millions per annum. Taking all workers into account, and making allowances for reduced oncost charges and the cost of two men in place of one in certain industries, the saving in cost of British production in 1920 would have been over 200 millions. Such a contribution towards reduction in cost and towards the revival of trade and employment is still open and available. The Geddes Committee suggest a saving of 86¾ millions, to be secured by many debatable and contentious means. A reversion to our former hours in industry could be achieved by an appreciation of its importance and necessity by those most directly concerned—the workers themselves—and they could do it at twenty-four hours' notice." There is, of course, another alternative. It is the fulfilment by labour of its promise to give in the short day as much as was given in the longer. We do not say that the augmentation of output by twelve per cent. or so would save the situation, but it would go some way towards it, and it would at least delay the further fall of wages which is inevitable in present circumstances. The bedrock of British industry is foreign trade. We cannot continue to exist as a great nation without it, and nothing will give us foreign trade—no Imperial agreement or Genoa Conference or tariff reform—if we cannot produce at a price at which purchasing nations can and will buy.

Budget day is approaching, and every manufacturer and merchant is wondering if the Chancellor of the Exchequer can decrease the burden of taxation. It cannot be too often said, particularly to working men, that unless there is a surplus profit on trading, progress is impossible. The company that succeeds in making no more than a small dividend cannot develop, it cannot introduce labour-aiding devices, it cannot adopt workshop improvements that make for the greater comfort of the workpeople, it cannot increase its accommodation and give more employment. It is only when a business earns more than it requires for its immediate needs that it acquires the ability to extend. Had "excess profits" remained in industry, factories would have developed and doles for unemployment might never have been needed. High taxation and high wages per piece are bleeding

our industries to death; unless both can be reduced, the improvement in trade which always seems in sight and always eludes us will again slip through our fingers.

Pacific Type Locomotives.

The new Great Northern "Pacific" type express locomotives which we illustrated in our last issue may safely be said to touch the high-water mark of passenger engine power on British railways, and if they do not actually reach the limit in size that is possible in this country, they are surely very close to it. Mr. W. Worsdell built for the North-Eastern the first six-coupled bogie engines for passenger service, one of which, it will be remembered, was shown at the Paris Exhibition of 1900. From that time up to the present, six-coupled ten-wheelers have gradually become almost standard for our heavy express services, as one railway after another has adopted this particular locomotive type. Just as Mr. Churchward led the way in building high-powered ten-wheelers, so he was the first to build for any British line an engine of the "Pacific" type, his locomotive named the Great Bear making its *début* on the Great Western in 1908. From that date up to the advent of Mr. Gresley's engines, no other "Pacifics" had made their appearance. Mr. Churchward evidently found that his ten-wheeled engines were fully equal to the needs of his railway, and the work those engines have done is certainly of the highest order.

Speaking on one occasion at the Institution of Mechanical Engineers on his "ten-wheelers," Mr. Churchward said they could pull two tons on the draw-bar at seventy miles per hour, and that it took a good engine to do that. With that statement every locomotive engineer will agree. But, whilst we recognise the excellence of the work done by the various designs of six-coupled bogie engines built in modern times—such as the North-Western "Claughtons," Mr. Urie's South-Western engines, and the Brighton "Baltics," to mention a few of them—we must confess to some doubt if they are the last word for high-speed service under modern conditions. For lower speeds on steep gradients, the higher tractive effort made possible by more adhesive weight obtained by three coupled axles is, of course, a great advantage, but at high speeds the tractive power available is set by the limits imposed by the boiler capacity, and as the power of the boiler is proportional to the ability of the fire-box to burn the fuel fired, it will readily be appreciated that the usefulness of the ten-wheeled express engine is rather sharply defined through limits set by its necessarily restricted fire-box volume and grate area. We might go so far as to say that at high speeds no work is done through the third pair of coupled wheels, those under the fire-box, and their place could then be better taken by a small pair of carrying wheels, which would permit the use of a larger fire-box. It is hardly possible to over-estimate the value of fire-box volume. The attainment of great power at high speeds is a matter of steam production, which is governed by the fire-box and grate. That being so, if we must have six-coupled engines for high-speed services, then the "Pacific" type is the one to be adopted, since it permits the employment of an ample fire-box. The principal characteristic of ten-wheeled six-coupled locomotives is the weight available for adhesion, which can be fifty per cent. in excess of that obtainable with either the eight-wheeled or "Atlantic" types. Adhesion weight makes tractive effort possible, but heating surface creates it, and the difficulty with six-coupled ten-wheelers is the attainment of sufficient boiler power to make available at high speeds a satisfactory percentage of the possible tractive power. Normally, the grate surfaces for eight-wheeled and ten-wheeled engines are about 25 and 30 square feet respectively, which means—other things being equal—that the steaming power of the ten-wheeler is 20 per cent. the greater. The "Pacific" has the same weight on the coupled axles as the ten-wheeled type, but the grate may be made of any size compatible with the general overall dimensions obtainable, as dictated by the loading gauge and allowable weights. If the grate is, say, 40 square feet, then the steaming power of the boiler will be 33 per cent. greater than for the ten-wheeler and 60 per cent. greater than that of eight-wheeled locomotives. Assuming that the three locomotive types—4–4–0, 4–6–0 and 4–6–2—mentioned have grate areas of 25, 30 and 40 square feet respectively and that each develops 45 cylinder horse-power per square foot of grate at 60 miles per hour, then the cylinder tractive effort will be 7030 lb., 8450 lb. and 11,250 lb., and if the maximum tractive efforts are 18,000 lb., 24,000 lb. and 29,000 lb., the percentage of the maximum tractive effort available at the cylinders will be 39, 35 and 39 per cent. The eight-wheeled and the "Pacific" type show to the best advantage, as would be expected, for the reason that the relationship between the weight on the coupled axles and the maximum tractive effort is about the same in each type. The "Atlantic" type has the same maximum tractive effort as the eight-wheeled type, but a cylinder power equal to that of the six-coupled ten-wheeler is obtainable, so that here the cylinder tractive force at 60 miles per hour is 8450, and the percentage of the maximum available at 60 miles per hour is 47 per cent. Like the "Pacific," the "Atlantic" provides for extensive grate area, so that the boiler power is only limited by the size of the cylinders, which must be so proportioned that the tractive effort available at high speed can be obtained at a reasonably short cut off.

Let us turn now to Mr. Gresley's "Pacific." Our attention is at once arrested by the design of the fire-box, which is of a form entirely new in this country. By extending the box forward into the barrel, a very satisfactory increase in volume has been obtained, and at the same time the length of the tubes has been kept within reasonable limits. Calculating on the inside diameter of the latter, the length between the tube sheets is 114 diameters, agreeing almost exactly with the "Pennsylvania" class K.4.S. Pacifics. Dividing the fire-box heating surface by the grate area gives a factor of 5.2 compared with 4.6 and 4.4 for Mr. Ivatt's "Atlantics" and the "Pennsylvania" Pacifics respectively. With augmented grate areas it becomes increasingly difficult to obtain relatively larger fire-box volumes; this being so, we congratulate Mr. Gresley on the result achieved in this respect with the Great Northern engine. The grate area is 41.25 square feet, and if 45 cylinder horse-power is obtained per square foot of grate, and we think the engine should readily develop that figure, the horse-power will be 1850—Mr. Gresley's own estimate is 1800.5!—meaning 1 horse-power for each 1.57 square feet of evaporative heating surface. The total weight of the engine and tender is 148.75 tons, and the weight, therefore, 180 lb. per horse-power, which is undoubtedly a very good figure when we consider that the tender weighs 56 tons. Calculating on the engine weight alone, the weight per horse-power is only 111.7 lb. In general, we may say that the same refinements in design and construction which characterised Mr. Gresley's three-cylinder fast goods engines, which we noticed at some length in our issue of December 31st, 1920, and on other occasions, are present in the construction of the new locomotives, and we have no hesitation in saying that, given suitably heavy trains, these "Pacific" type locomotives should prove a valuable addition to the locomotive stock of the Great Northern. In design, like their sisters, they stand well to the forefront of modern locomotive construction.

Obituary.

ISOJI ISHIGURO.

News has reached us of the death in January last of the famous Japanese engineer, Dr. Isoji Ishiguro. Dr. Ishiguro was born at Kanazawa, Kaga, Japan, on June 10th, 1855. He was educated at the Tokio University, graduating in July, 1878, with the degree of "Rigaku-shi" (Master of Science). For one year thereafter he was engineer to the Yokohama prefecture, during which time he made a detailed survey for the Yokohama waterworks, and then came to England to serve as a pupil for three years with the late Mr. Edward Easton, to whom he subsequently acted as assistant engineer. While with Mr. Easton he was engaged upon the Herts and Essex waterworks extension, Grays waterworks, Faversham swing bridge, Deal waterworks, an experimental electric lighting plant at Stafford House (Duke of Sutherland's) with Gramme machine in 1882, &c.; and was responsible for the design of the gasholder at East Grinstead, a bridge over the river Naver, a bridge over the Halladale, Casheldue bridge, the pumping establishment at Khatatbeh in Egypt, irrigation work in Behera District, and an iron roof for the circular tank at Alexandria waterworks. He was also engineer to a manufactory of "Insulite," and acted as inspector for pumps and irrigation plants made at the Erith Ironworks—then Messrs. Easton and Anderson—being sent out to Egypt, on behalf of Mr. Ed. Easton.

On his return to Japan in 1885 Dr. Ishiguro entered the service of the Japanese Government and remained in it until he retired at the end of 1906. Among the numerous works for the design of which he was responsible during that period were the drainage system of the then foreign settlement at Yokohama; Keelung harbour works, Formosa; improvements of the rivers Chikugo, Tone, and Shinano; harbour works at Moji, Wakamatsu, and Miike; engineering work for the establishments of the Government naval stations at Kure, Sasebo, and Maidzuru; and civil engineering work in general for the naval expansion work from 1895 to 1906. He was also engaged at the Yokohama harbour works as chief engineer after the death of the late Major-General Palmer in February, 1893, till 1896. It was in accordance with his scheme and under his actual supervision that the Japanese naval authorities succeeded in raising the six sunken Russian warships, Retvizan (12,700 tons), Poltava (11,000 tons), Popieda (12,680 tons), Peresviet (12,674 tons), Pallada (6700 tons), and Bayan (7800 tons) in Port Arthur after the Russo-Japanese War in 1904 to 1905. After he had retired from the Government service at the end of 1906 he became chief engineer to the Uji River Hydro-electric Power Company, Limited, and designed and carried out a hydro-electric plant of 50,000 horse-power, making use of water from the Lake Biwa.

Among the appointments and positions which Dr. Ishiguro held during and subsequent to his period of Government service were those of chief engineer of civil engineering works and also the Inspector-General of Works Department of the Imperial Japanese Navy from 1886 to 1890, and again from 1898 to 1906; lecturer upon sanitary engineering at the Imperial University, Tokio, from January, 1885, to June, 1886; adviser to the Imperial Japanese steel works; member of Committee of the Tokio City Improvement; of the Imperial Japanese Seismological Society; and of the Japanese Government Railway Construction. He was a member of the House of Peers, having been appointed thereto by the Emperor in December, 1907; he had also held an honorary position, the Imperial Court Attendance, called "Kinkeinoma-Shiko," since July, 1908. He was member of the Institution of Civil Engineers (London), member of the Imperial Japanese Seismological Society (since 1891), and member of the Engineering Society of Japan (Tokio). In 1891 he obtained the degree of Kogaku-hakushi—Doctor of Technical Science—at Tokio University.

BOOKS RECEIVED.

The Airplane Engine. By L. S. Marks. London: McGraw-Hill Publishing Company, Limited, 6 and 8, Bouverie-street, E.C. 4. Price 30s. net

Metallurgy of Zinc and Cadmium. By H. O. Hofman. London: McGraw-Hill Publishing Company, Limited, 6 and 8, Bouverie-street, E.C. 4. Price 20s. net.

Giesserei—Handbook Herausgegeben von Verein Deutscher Eisengiessereien Giessereiverband in Düsseldorf. München: R. Oldenbourg, 8 Glückstrasse 8. Price M. 300.

Manufacture of Portland Cement. By A. C. Davis. Third edition revised and enlarged. Dublin: John Falconer, 53, Upper Sackville-street. Price 25s. net.

Sharing Profits with Employees. By J. A. Bowie. London: Sir Isaac Pitman and Sons, Limited, 39–41, Parker-street, Kingsway, W.C. 2. Price 10s. 6d. net.

The Locomotive Engineers' Pocket Book and Diary, 1922. London: The Locomotive Publishing Company, Limited, 3, Amen-corner, Paternoster-row, E.C. 4. Price 3s. 6d. net.

The Elements of Fractional Distillation. By Clark Shove Robinson. London: McGraw-Hill Publishing Company, Limited, 6 and 8, Bouverie-street, E.C. 4. Price 12s. 6d. net.

Construction Cost Keeping and Management. By H. P. Gillette and R. T. Dana. London: McGraw-Hill Publishing Company, Limited, 6 and 8, Bouverie-street, E.C. 4. Price 25s. net.

Research in Industry: The Basis of Economic Progress. By A. P. M. Fleming, C.B.E., and J. G. Pearce. London: Sir Isaac Pitman and Sons, Limited, Parker-street, W.C. 2. Price 10s. 6d. net.

Protective Relays: Their Theory, Design and Practical Operation. By Victor H. Todd. London: McGraw-Hill Publishing Company, Limited, 6 and 8, Bouverie-street, E.C. 4. Price 12s. 6d net.

"The Practical Engineer" Mechanical Pocket Book and Diary, 1922. London: The Technical Publishing Company, Limited, 1, Gough-square, Fleet-street, E.C. 4. Prices 2s. net and 2s. 6d. net.

Mechanical Testing: A Treatise in Two Volumes. By R. G. Batson and J. H. Hyde. *Vol. I.: Testing of Materials of Construction.* London: Chapman and Hall, Limited, 11, Henrietta-street, Covent Garden, W.C. 2. Price 21s. net.

Handbook for Ironfounders. Published for the Frodair Iron and Steel Company, Limited. London: The Locomotive Publishing Company, Limited, 3, Amen-corner, Paternoster-row, E.C. 4. Price 3s. 6d. net.

An Introduction to the Study of Metallography and Macrography. By Léon Guillet and Albert Portevin. Translated by Leonard Taverner. With an introduction by H. C. H. Carpenter, F.R.S. London: G. Bell and Sons, Limited, York House, Portugal-street, W.C. 2. Price 30s. net.

Board of Education. Catalogue of the Collections in the Science Museum, South Kensington, with descriptive and Historical Notes and Illustrations: Aeronautics. London: His Majesty's Stationery Office, Imperial House, Kingsway, W.C. 2. Price 1s. 6d. net.

Institution of Naval Architects.

No. III.*

THE paper by Mr. T. C. Tobin on "A Method of Determining the Natural Period of Vibration of Ships," of which an abstract appears below, and which was taken in the afternoon of Thursday, the 6th inst., elicited a short but informative discussion.

THE VIBRATION OF SHIPS.

Having pointed out the defects of the ordinary formula for determining the fundamental periodicities of the vibration of a ship, the author described a new method of calculation which was based on the theory of vibrating bars as developed by the late Lord Rayleigh. This method took account of the fact that the distribution of the weight of the vessel lengthwise is such as to prohibit the structure being regarded as a uniform bar. The calculation is based on the weight distribution curve for the ship and on certain auxiliary curves which vary with the number of nodes in the vibration. Applied to the case of an oil tanker, the calculations indicated a two-node vibration frequency of 75.4 per minute as compared with 76 found by actual investigation. For a large passenger liner a Schlick pallograph indicated two distinct periods of vibration having frequencies of 58.8 and 150 per minute. The calculated two-node vibration frequency for this vessel was 59.4 and the three-node vibration frequency 148.7 per minute. In the calculations for both these vessels Young's modulus was taken at 12,500 inch-ton units.

Mr. Nicholls congratulated the author on having evolved an ingenious method of determining the natural period of vertical vibration of ships based on the assumption that the curve of amplitude of vibration and the position of the nodes were the same in a ship as in a uniform bar. He (the speaker) suggested, however, that that might not be a correct assumption except in cases of small variations of mass and flexional rigidity.

Mr. Bailey, who has been working on similar lines, said Mr. Tobin had assumed that the neutral axis of a ship when undergoing flexural vibrations was the same as that of a uniform rod of the same length. This enabled him to calculate the potential and kinetic energies, and by equating them to obtain the frequency. In the case of a warship, however, a correction of some order of magnitude would be required. There were further sources of error in the case of warships. Mr. Nicholls was at present experimenting with a dynamic model of a ship, and he understood that experiments would also be made in an actual ship. The data thus obtained should be sufficient to establish a method of calculating periods of vibration. Mr. Tobin had given them the basis of such a method.

The paper on the agenda for the evening session on April 6th was that by Mr. James Richardson, on "Diesel Machinery for Single-screw Motor Ships." We print a full abstract of it on another page.

Opening the discussion, Engineer-Admiral Sir George Goodwin said he believed it was possible to use slow-running Diesel engines very much more easily than was possible a few years ago, and that in itself was evidence of the great care that had been given in this country to the development of the Diesel engine. That fact struck him as being one of the most important in the paper. Diesel engines had been tried in the Navy for a certain group of vessels for main engine work, and it was decided that, in those ships, boilers should not be fitted. As, however, a very thick oil had to be used, there was no way out of it but to have boilers fitted. Directly they were installed, very strong reasons were advanced for the removal of the Diesel engines, and although that course was resisted in the case of one ship, the Admiralty was forced in the other vessels to revert to the use of steam. One ship had electrically driven auxiliaries, and what had struck him then was the high cost of the electrical equipment. He believed it would always be found that electrical auxiliaries were more expensive, but if they could be got at a reasonable cost there was economy in their use. The possible use of exhaust gases was also receiving considerable attention, but that problem was an inherently difficult one. The specific heat of the gases was very low, and there was no latent heat to be got out of them. The best application seemed to be in connection with evaporators. It had been used in the German submarines and also in our own oil ships in the Navy with a fair amount of success, but the apparatus was cumbersome and the efficiency rather low. The paper seemed to labour air injection, but a fair case could be made out for solid injection as against air injection to cure some of the evils that had been mentioned.

Mr. D. B. Morison said the author dealt indirectly with a problem of vital interest to the mercantile marine. His experience was that the technical aspect had only a passing interest for the shipowner; what he asked for was that cargoes should be delivered year in and year out according to programme and with the least expenditure on fuel and labour, and with as few delays as possible resulting from repairs, breakdowns and overhauls. For freedom of delays arising from accidents, the reciprocating steam engine was unsurpassed, but the internal combustion engine had a thermal efficiency far ahead of its steam competitor, and the problem for the engineer was to develop the oil engine to a point where it would be as reliable as the steam engine. Reliability of the machinery equipment of ships was absolutely essential to success in ship-owning. A cargo ship, to be a commercial success, must be propelled by machinery simple in design, strong in construction, economical in fuel consumption, and, above all things, reliable in working over long periods when in charge of engineers of average ability and average experience. The data in the paper with regard to the single-screw ship would be very helpful to the industry as a whole. That the solution of the marine Diesel problem was difficult was evidenced by the number of types and their variants now under construction. Considerable differences of opinion prevailed among the designers of Diesel engines, and it would take a long time to prove who was right and who was wrong. It would not be possible to settle that problem and find the best engine without co-operation on broad lines, and it was with that object in view that his firm made an offer to the Admiralty, the Institution of Mechanical Engineers, and the Institution of Naval Architects to place a vessel with Diesel machinery at their entire disposal for the purpose of testing. The offer had been accepted, and the results, whatever they might be, would be made public in the hope that they would contribute to the more rapid development of Diesel marine engines generally. Moreover, similar offers had since been made by other builders of Diesel engines, so that we might look forward to the dissemination of much valuable data. Every member of the Institution would be glad to know that the Lords of the Admiralty had expressed their entire approval of the scheme, and had appointed the Engineer-in-Chief of the Navy to act on their behalf. In order to secure maximum economy in fuel with a Diesel engine ship it was essential that all the power required in the engine-room and on deck should be supplied by Diesel engines. Therefore, all auxiliaries must be electrically driven in order to get the most economical results. For short voyage ships, such as the Pinzon, electric driving was no doubt a good solution, but bearing in mind his own strong views as to the reliability of steam-driven auxiliaries, and also remembering the fact that steam-driven auxiliaries seldom gave any trouble, he would prefer, speaking as an engine builder, that meantime, with ocean-going vessels, the steam auxiliaries should be retained in the engine-room for stand-by purposes, and thus give the ship's engineer more time to devote to the good working of the main engines at sea and to their adjustment in port.

Mr. H. A. Ruck-Keene hoped that the appeal that other firms would follow the example of Messrs. Richardsons, Westgarth and Co., and offer Diesel engine ships to the Committee, would be received and acted upon in the right spirit. In the opening paragraph, the author stated that single-screw motor ships of 2000 tons deadweight and over were exceptional, but from Lloyd's Register he found that there were 210 sea-going vessels fitted with Diesel engines, of which 178 were of the four-stroke cycle type and 32 of the two-stroke cycle type. Of these 210 vessels, 48 were single-screw vessels, or 25 per cent., and of these single-screw vessels, 11 were 1000 to 2000 tons gross, 5 were between 2000 and 3000 tons gross, and 12 were 3000 tons and over. In the early days there were certain failures due to design in various parts of the engines, but with the experience gained during the past eleven years, there had been improvements, such as alterations to the design of the cylinder covers, modifications of the design of the cooling arrangements, &c., which had overcome these troubles. From the figures he had given it would be seen that far more Diesel engines of the four-stroke type had been built than of the two-stroke type, and as a consequence experience had been greater with the former than with the latter. He was of opinion that certain four-stroke Diesel engines were as reliable as steam engines at sea, and he saw no reason why the two-stroke engine should not be equally reliable. He also thought the time had arrived when one might expect single-screw engines to be built in powers up to 3000 indicated horse-power. The author had mentioned three ways in which compressed air might be lost, but there was another, and that was the human element in the person of the engineer in charge. It was easy to keep the engines too long on air before turning on the liquid fuel. The rule in Lloyd's Register was that there should be sufficient reserve of air to make twelve consecutive startings of the engines. It had been suggested that there should be a more definite ruling than that, but in view of the varying types of engine in use he doubted whether it was desirable at present to alter the ruling. The auxiliary machinery was a very important part of a ship's equipment. A large number of Diesel engine ships were fitted with electrically driven auxiliary machinery, driven by Diesel engines, and that was possibly the most economical way. In later vessels it had been found that steam was required for steaming out the tanks, and that it was necessary to have steam boilers on board. Therefore steam auxiliaries were used for the most part. The use of exhaust gases was tried in two vessels built by Krupps for heating a low-pressure boiler employed for heating purposes in the ship, but he did not think it was a great success. Other systems had been tried, and it was a question of what was the most economical and efficient way of doing it.

Mr. Le Mesurier said that for single-screw ships he did not think the two-stroke engine could be ignored. The principal characteristic of the single-screw Diesel engine, as distinct from engines for the twin-screw ship, was that it was necessary to run at a lower number of revolutions, and on that account the two-cycle engine was preferable. He would like to make a comparison between the engines of the Pinzon and an engine of exactly the same power of the two-cycle type. According to the figures in the paper, the Pinzon engine developed 1250 brake horse-power at 120 revolutions per minute, the cylinder diameters being 24½in. and the stroke 38½in., there being six cylinders. The two-cycle engine he had in mind would have four cylinders instead of six, and the dimensions would be less than those of the four-cycle type. That was an important fact. The two-cycle engine ran at 100 revolutions per minute, instead of 120, as in the four-cylinder type. The piston speed of the four-cycle engine was 765ft. per minute, whereas that of the two-cycle engine was 615ft. per minute. As to the respective weights, a figure had not been given in the paper for the four-cycle engine. The two-cycle engine was about 165 tons, and it would be interesting if the author would give the figure for the four-cycle engine. Thus it would be seen that the two-cycle type ran with 20 per cent. less revolutions, with less piston speed, and it developed the same power on four cylinders instead of six cylinders. The brake mean effective pressure was the same in both cases, and although it was commonly stated that the two-cycle engine should not run at the same, or as high, mean pressure as the four-cycle engine, he personally thought the opposite was true. The heat stresses, which had been one of the great arguments against the two-stroke engine, were, in fact, not so severe in the part which was usually affected by heat stresses, viz., the cylinder cover. The two-cycle design enabled that cover to be made in a very simple form. The rating given by the author for the Pinzon engines must be the overload rating, as in Table II. the revolutions given for the main engines were 115. That might be due to propeller design or not running up to full load conditions. In comparing the Pinzon with the steamship, the revolutions for the Diesel ship were given as 106. He did not know whether there was any significance in that difference, but personally he should have thought the mean pressure was rather too high for a four-cycle engine. On the other hand, the two-cycle engine could certainly run at that piston speed comfortably. That had been shown to be the case with three ocean-going vessels with which he was personally acquainted. These mean pressures had, indeed, been exceeded. In making this comparison, it was only fair to say that the two-cycle engine was equipped with a scavenging pump, which was not necessary with the four-cycle engine, but even taking that into consideration he contended that the figures he had given showed that the two-cycle engine must be taken into consideration in a paper purporting to deal with the Diesel engine for single-screw motor vessels. He was glad the author was in favour of electrically driven auxiliaries. The duplication of the injection air service seemed to be a refinement hardly justified. The difficulty with the valves in the cylinder head was got over in the two-cycle type by dispensing with them altogether.

Mr. Reavell raised the question of the provision of a duplicate compressor which the author had added to his engine, and suggested that it would be cheaper and more economical to fit an 8 horse-power emergency set. That would be more reliable when manœuvring, and generally was much better than making the main compressors very large. Large main compressors were not very much use to the Diesel engine in narrow waters. He suggested that the Pinzon would have been better equipped if one compressor had been fitted instead of two, this one compressor being just large enough for injection—with a reasonable margin, say 15 per cent. Thus the whole cost of the second compressor would be saved, and part of the money so saved could be used to increase the size of the emergency compressor set. The emergency compressor would be entirely self-contained and independent of the other machinery in the ship, the arrangement being such that the air bottles were automatically filled up as they were drawn upon. That arrangement had great advantages when manœuvring in narrow waters.

Mr. Martin agreed that more use should be made of the exhaust gases, and it might even be possible to dispense with the donkey boiler if that were done, and it might also be possible to arrange for the driving of the auxiliary by that means.

Baron Steinheil said he did not believe in twin-screw installations for ships above 7000 horse-power. In a ship of 10,000 tons deadweight capacity, with a shaft horse-power of 2600, a single-screw arrangement was possible with the two-stroke engine, using four or six cylinders. In his opinion, engine-room auxiliaries should be independently driven and be in duplicate. Electrical driving of auxiliaries was expensive.

Mr. Richardson, replying to the discussion, said Mr. Morison had made an important announcement with regard to the trials of the vessels which his firm was building with Beardmore-Tosi engines for the Furness-Withy Line, and it was to be hoped that other constructors of marine Diesel engines in this country would follow that generous lead, and dispel the secrecy

* No. II. appeared April 14th.

which had hindered the development of the Diesel engine for marine purposes hitherto. As regards the two-cycle engine, he had not overlooked its claims for single-screw ships. He could not find any reason for the suggestion of Mr. le Mesurier that the 1250 horse-power of the Pinzon engines was the overload rating. It was known absolutely and definitely, as the result of ten or fifteen years' experience with four-cycle engines that with a mean effective pressure of 95 lb. per square inch, the horse-power rating was not the overload rating, and he submitted that there was no such evidence in regard to the two-cycle engine. A difficulty with the two-cycle engine which did not arise with the four-cycle was that of carbon falling from the cylinder and piston head into the lubricating system. He considered the duplication of the air injection apparatus absolutely essential in the case of a single-screw ship. In reply to Mr. Reavell, he said that the reason for putting in the larger compressor and not a larger auxiliary compressing plant was to give greater reliability in the supply of starting air to the main engine.

Locomotive Economy.*

It seems advisable to consider this subject from the constructive standpoint of indicating what constitutes good design as demonstrated by locomotives in actual service, rather than to attempt to point out the defects in locomotives which do not show maximum efficiency.

If any power plant or engine is not properly proportioned for the work it has to do, the most expert skill in operation can reduce only in part the waste resulting from having such equipment in service.

First, considering the design of steam locomotives from the standpoint of new equipment, when a railway company is in the market for new locomotives its requirements may be met sometimes by duplicating locomotives in service on their road, but adding newly developed attachments which make for increased efficiency and economy. More frequently, however, it will be found that increased traffic, change from wooden to steel cars, improvement in track, road bed and bridges, &c., will justify and make advisable the adoption of locomotives of a larger and more powerful type.

Then careful consideration must be given to service requirements—maximum loads to be hauled, capacity of cars, approximate proportion of loaded to empty cars per train, gradients, curves, running time over divisions, maximum allowable load per axle, location of coal chutes and water tanks, clearances, conditions under which trains must be started, and any other special requirements of the service.

Having determined the draw-bar pull necessary, it remains to design a locomotive that will have the following efficiency requirements :—

(1) A draw-bar horse-power for the minimum amount of fuel.

(2) A draw-bar horse-power for the minimum amount of weight of locomotive and tender.

(3) A draw-bar horse-power for the minimum cost of repairs.

Fuel Economy.

As standard practice in modern locomotives, a sectional brick arch in the fire-box and a fire tube superheater should be applied as a means of saving fuel in any class of service. A sectional brick arch is low in first cost, easily applied, and easily renewed. It usually accomplishes a fuel saving of from 10 to 12 per cent. in coal-burning engines, and about 5 per cent. in oil-burning engines.

The very general use of superheaters has gradually brought about improved conditions of cylinder lubrication, which now make it possible and desirable for the greatest economy to use a high degree of superheat, 250 deg. to 300 deg. now being considered the best practice. A saving of 25 to 30 per cent. can be obtained.

For the best results with bituminous coal the length of locomotive boiler tubes should be approximately within the following limits :—

Size of tube.	Distance over tube sheet.
2in.	18ft. to 19ft. 6in.
2¼in.	22ft. 6in. to 24ft. 6in.
2½in.	28ft. to 30ft.

The evaporative capacity of the boiler should be as nearly 100 per cent. of the maximum steam requirements of the cylinders as the type of locomotive will permit. Based on 100 per cent. boiler, the grate area should be sufficient to prevent the maximum coal consumption per square foot of grate per hour from exceeding, for bituminous coal, 120 lb., and for anthracite coal 55 lb. to 70 lb., depending on size. When the total coal consumption exceeds 6000 lb. per hour it is generally necessary to apply an automatic stoker. These have now been so adapted to locomotive requirements that a properly designed stoker will show economy over hand firing, aside from the necessity of its use on account of the coal consumption being greater than the physical capacity of one fireman if the boiler were hand-fired.

The cylinder proportions and diameter of the drivers should be such as will develop maximum horse-power at the ruling speeds for train movements. The greatest horse-power of locomotive cylinders will usually be developed with a piston speed ranging from 700ft. to 1000ft. per minute. Therefore, if other traffic conditions will permit, the operation of trains within these limits should show the greatest running economy.

The weight on the locomotive drivers gives an engine friction, independent of other factors, of 22 lb. per ton. The desirability of avoiding excess weight on the drivers from this standpoint alone is therefore readily apparent. When the type of engine will permit this weight should not exceed what is necessary to give a satisfactory factor of adhesion ; that is usually four and a-quarter times the maximum tractive power. All weight in excess of this and all other excess weight and excess tender weight should be eliminated, as far as this can be done without detriment to the design of engine and tender. This applies with particular force to the machinery parts of the engine, especially those parts which affect the counterbalance. All saving in weight in these parts usually produces a similar saving in counterbalance weights and a reduction in the dynamic augment, which is very desirable from the standpoint of track and road bed maintenance. The use of special materials to keep down weight is often amply justified if repair parts can be obtained promptly when required. This, in the past, has often been the cause of delay, but it can be guarded against by carrying a few spare parts in stock ready for renewals. High-tensile alloy steel can frequently be used to advantage for driving axles, crank pins, main and side rods, piston-rods, &c.

A few concrete examples of what has been accomplished in service by locomotives designed to yield maximum efficiency may be of advantage. Notable designs, for which data is available, are as follows :—

Pacific type passenger locomotive No. 50,000, built by the American Locomotive Company.

Decapod type goods locomotive Class 11s, built by the Pennsylvania Railroad Company.

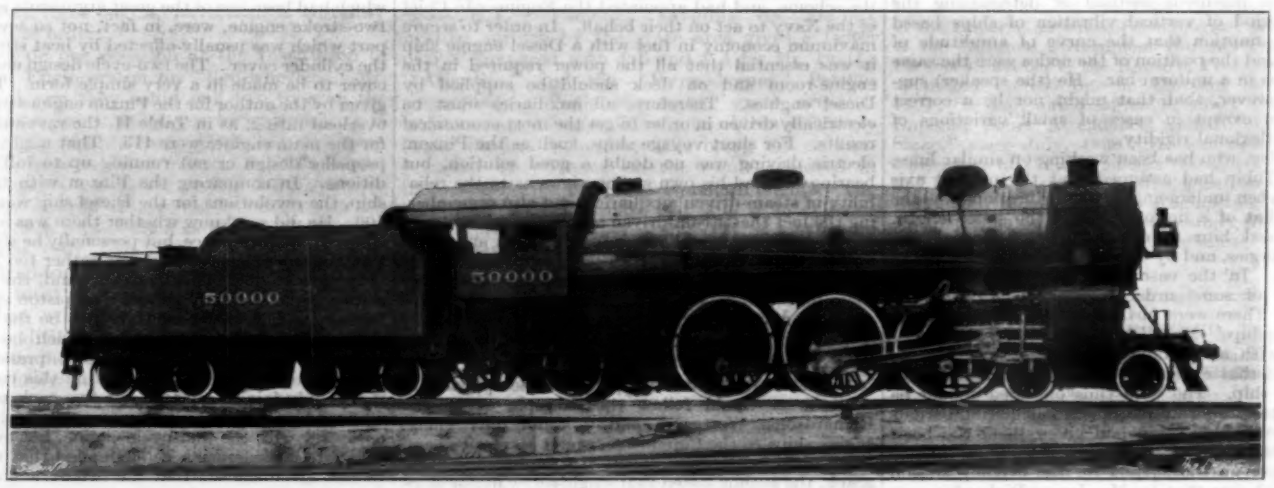
Heavy Mallet special service locomotive, built for the Virginian Railway by the American Locomotive Company.

American Locomotive Company Engine, No. 50,000.

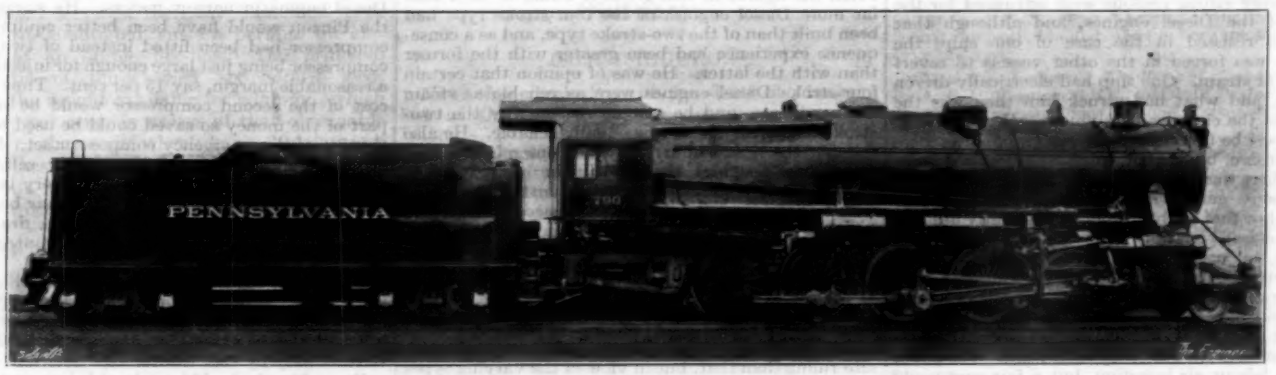
Locomotive 50,000 was built by the American Locomotive Company in 1910. It was designed and constructed at the builders' expense to demonstrate the maximum tractive power with adequate boiler capacity that could be obtained while keeping the adhesive weight below 60,000 lb. per driving axle. Untrammelled by any outside specifications or the necessity of conforming to any railway's existing standards, the builders had a free hand to embody in this design their ideas of the best engineering practice. To accomplish the purpose of the design—the maximum capacity per pound of weight—the largest boiler capacity within the predetermined wheel loads was the essential feature. This end was obtained by eliminating every pound of weight in all the parts that was not necessary to strength and durability, utilising the weight thus saved to provide a larger boiler, and by increasing the capacity of the boiler thus secured by combining in one design the most approved fuel-saving devices to obtain the utmost economy in boiler and cylinder performance. Many of the large Pacific type locomotives with drivers 75in. in diameter and over in operation to-day greatly exceed locomotive 50,000 in total weight.

An average of all the important engines of this type, including locomotive 50,000, shows approximately 1000 lb. less tractive power with an increase of 17,400 lb. in weight with the very slight advantage of only 1½ per cent. in boiler capacity.

Locomotive 50,000 delivers one cylinder horse-power for every 110.8 lb. of weight and one boiler horse-power for every 120.3 lb. of weight. In actual tests it developed an average rate of 2.21 lb. of coal per indicated horse-power hour, a low rate on one test of 2.12 lb. of coal per indicated horse-power hour, an average rate of 16.85 lb. of steam per indicated horse-power hour, a low rate on one



PACIFIC TYPE PASSENGER LOCOMOTIVE, BUILT BY THE AMERICAN LOCOMOTIVE COMPANY

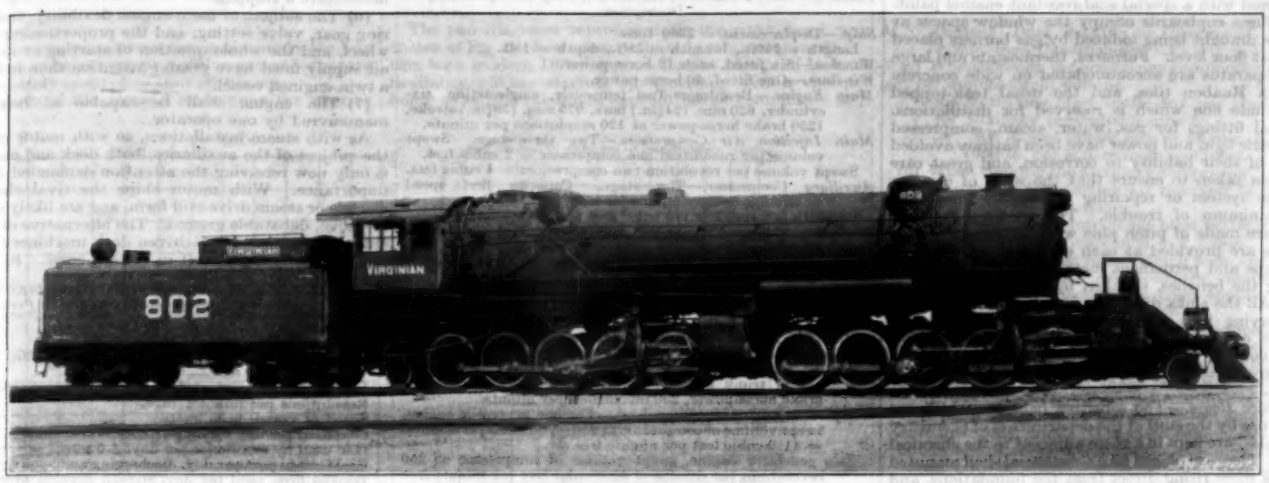


DECAPOD GOODS LOCOMOTIVE, CLASS 11 S, BUILT BY THE PENNSYLVANIA RAILROAD COMPANY

* From a paper on "Avoidable Waste in Locomotive Operation as Affected by Design," by James Partington, Estimating Engineer, American Locomotive Company, New York, N.Y., read before the Railroad Division of the American Society of Mechanical Engineers, December 9th, 1921.

VIRGINIAN RAILWAY—HEAVY MALLET SPECIAL SERVICE LOCOMOTIVE

THE AMERICAN LOCOMOTIVE COMPANY, NEW YORK, ENGINEERS



test of 16.5 lb. of steam per indicated horse-power hour, a maximum indicated horse-power of 2216, or one horse-power for every 121.4 lb. of weight.

The thought occurred that possibly 50,000 was built too light and that later on, in order to keep the engine in service, many of the parts might require strengthening. Locomotive 50,000 was purchased by the Erie Railroad and numbered 2509. Mr. Wm. Schlafge, mechanical manager of the Erie, states that since the locomotive was received it has been necessary to make very few changes. The guide yoke was reinforced on account of working. Guide yoke blocks were also made solid on the guide yokes. The trailer spring sliding block was changed to the same type as used on their K4 Pacific type locomotives. No other changes or alterations have been made. Yet from the time this locomotive was placed in service on the Erie Railroad up to March 1st, 1920, it had made a total mileage of 351,800. Ten years of service, coupled with 350,000 miles of running, demonstrate the strength of the design and the figures given indicate remarkable performance.

PENNSYLVANIA RAILROAD, CLASS 11s.

While the design of engine 50,000 represents the best practice of the present day as measured by the economical operation of passenger locomotives, the development of heavy goods power involves the consideration of other factors that materially affect the design. In 1915 the Pennsylvania Railroad found that for the economical operation of its line a tractive power about 25 per cent. in excess of the "Mikados" then in use was desirable. In working on the design for such an engine, an attempt was made to obtain better economy in performance by a radical departure in cylinder proportions. The accepted practice in proportioning cylinders is to arrange for a cut-off of nearly 90 per cent. of the stroke, so that the starting torque may be as uniform as possible.

As the adhesive weight limits the cylinder diameter if excessive slipping is to be avoided, it is obvious that on long gradients, on which the maximum tractive effort is required, the long cut-offs use steam in a most uneconomical manner. As the Pennsylvania Railroad has several such long gradients on its line, the new design adopted involved a limitation of the cut-off to about 50 per cent. in place of 90 per cent. and an increase in the cylinder diameter to give sufficient torque at this cut-off to utilise fully the adhesive weight. The expected increase in economy of coal and water due to the shorter cut-off has been fully realised.

Not only has the engine shown remarkable efficiency, but the economy under wide range of load is especially remarkable.

We are fortunate in having available a very complete test of this engine made on the testing plant at Altoona. (Bulletin 31, P.R.R. Testing Plant, 1919, copyrighted.) This test shows a water rate of 15.4 lb. per indicated horse-power hour with a total indicated horse-power of 3080 at 40 per cent. cut-off and a coal consumption 2.9 lb. The lowest coal consumption recorded is 2.00 lb. per indicated horse-power, obtained at an output of 1777 indicated horse-power and a cut-off of 30 per cent. The thermal efficiency of the locomotive is also high and well sustained over a large range, a maximum of 8.1 being attained at an output of 1777 indicated horse-power, and the range being from 5.1 per cent. at 776 indicated horse-power to 5.3 per cent. at 3486 indicated horse-power, with an average of over 7 per cent. for the usual operating conditions.

The highest draw-bar pull recorded in these tests is 76,211 at a speed of 7.4 miles per hour, but in road service a pull of 80,640 lb. has been recorded at 7.2 miles per hour. The indicated tractive effort plotted from a card taken at 7.4 miles per hour at 55 per cent. cut-off is slightly over 90,000 lb. This design gives a calculated figure of 88.9 lb. per cylinder horse-power, the lowest on record. During the tests an indicated horse-power of 3486 was developed, giving a weight of 106.2 lb. per horse-power. The weight per boiler horse-power does not compare as favourably, however, as it is 145.4 lb. The Belpaire firebox contributes materially to this excess.

VIRGINIAN 2-10-10-2 TYPE LOCOMOTIVES.

The large 2-10-10-2 Mallet engines for the Virginian Railway were designed to meet their unique conditions. This road was built as an outlet to certain bituminous coalfields of West Virginia. Practically the entire revenue business is confined to hauling coal to the shipping docks at Sewall's Point, the westbound revenue goods being negligible in amount, as only one town of any importance, Roanoke, is situated on the line. As the development of the coal fields proceeded the tonnage to be handled increased rapidly, rising from 2,141,009 in 1911 to 7,621,555 in 1920, and in order to handle the business at a profit the maximum attainable capacity in motive power was demanded. Having fixed on 100 cars as the maximum number that could safely be handled in a single train, the car capacity increased to 120 tons, it was estimated that a locomotive of 147,000 lb. tractive power would be needed to haul the train from Princeton to tidewater, a helper being used for a gradient of .6 per cent. ten miles long over the Alleghenies. The 2-10-10-2 Mallets were designed to meet these conditions, and their operation has been very successful. They have handled trains of 16,000 tons on a .2 per cent. gradient with the lowest consumption of coal per ton-mile ever recorded. Unfortunately, accurate tests of coal and water per dynamometer horse-power are not available owing to the fact that there is no dynamometer of adequate capacity to be had at present. However, on May 25th a train of 15,725 tons behind the tender was hauled from Princeton to Roanoke at a rate of 26.9 lb. of coal per 1000 ton-miles, and on May 27th a 75-car train of 12,070 tons showed the same figure for coal per 1000 ton-miles.

One of these engines has hauled a train of 110 cars weighing 17,250 tons from Victoria to Sewall's Point, which is believed to be the heaviest train ever handled by one engine. The ruling adverse gradient was .2 per cent.

The principal dimensions of the three locomotives cited and a comparison of the horse-power characteristics—calculated by the American Locomotive Company's method—are embodied in the accompanying table.

Modern Maximum Efficiency Locomotives.

	No. 50,000 Erie 462 Bituminous coal Conical connection	No. 802 Virginian 210,102 Bituminous coal Extended wagon top	No. 790 Pennsylvania 2100 Bituminous coal Conical connection
Road			
Type			
Fuel			
Boiler, type			
Boiler, diameter	76¼–87in.	105¼–118¼in.	87–90¼in.
Weight on drivers	172,500	617,000	342,050
Weight on truck	49,000	32,000	29,750
Weight on trailer	47,000	35,000	—
Weight, total	269,000	684,000	371,800
Driving wheel diameter	70in.	56in.	62in.
Cylinders	27in. × 28in.	30in. & 48in. × 32in.	30½in. × 32in.
Boiler pressure, lb.	185	215	250
Tractive power, lb.	40,600	147,200	90,000
Factor of adhesion	4.25	4.08	3.80
Cylinder horse-power	2,427	5,040	4,182
Grate, length and width	114 × 75¼in.	144 × 108¼in.	126 × 80in.
Grate area, sq. ft.	59.5	108.25	70.0
Tubes—			
Number	207	381	244
Length	22ft.	25ft.	19ft. 1in.
Spacing	2¼in.	2¼in.	2¼in.
Thickness	11 B.W.G.	11 B.W.G.	.125in.
Diameter	2¼in.	2¼in.	2¼in.
Flues—			
Number	36	70	48
Diameter	5½in.	5½in.	5½in.
Thickness	9/16in.	9 B.W.G.	.18in.
Combustion chamber, length	None	36in.	42in.
Brick arch	Security	Gaines	Security
Heating surface—			
Fire-box	248	532	290
Tubes, water side	2,672	5,592	2,731
Flues, water side	1,136	2,511	1,313
Total	4,056	8,635	4,334
Boiler horse-power	2,250	4,800	2,553
Steam rate calculated pounds per H.P. hour	20.8	19.7	20.8
Coal rate calculated pounds per H.P. hour	3.25	3.1	3.25
Superheater—			
Number of units	36	70	42
Diameter	1¼in.	1¼in.	1¼in.
Heating surface	879	2,120	1,418
Tender weight in running order	161,500	214,300	182,000
Tender capacity coal, tons	14	12	17½
Tender capacity, water, gallons	8,000	13,000	9,000
Weight of locomotive in pounds per cylinder H.P.	110.6	135.7	88.9
Weight of locomotive in pounds per boiler H.P.	119.6	142.5	145.4
Best actual performance—			
Steam rate, pounds per H.P. hour	16.5	—	15.4
Coal rate, pounds per H.P. hour	2.12	—	2.0

Cotton Research.

THE following additional particulars concerning the Shirley Institute, which was formally opened last month by the Duke of York, and of the British Cotton Industry Research Association for co-operative research work which founded it, will doubtless be of interest to our readers. The Association is open to British corporations and firms engaged in any of the branches of the cotton industry, the subscriptions being based upon the amount of capital for the time being employed in the business of the member. The Council consists of thirty-two members, and includes representatives of employers and operatives' organisations and other bodies. The Institute is situated at Didsbury, near Manchester, and the estate covers altogether about 14½ acres. Incidentally, it will be of interest to engineers to know that the house which forms the central administrative block was formerly known as "The Towers," and was the residence of the late Daniel Adamson, where the possibilities of constructing the Manchester Ship Canal were first discussed. It was necessary for the purposes to which it was to be put that the Institution should be in pleasant surroundings, free from vibration due to traffic, and yet easy of access, both from the University and from the centres of industry. In addition to the administrative offices, the main building contains a library and information bureau, with over 2000 works on cotton. The laboratories are in a separate building, and as it is impossible to predict which will become the predominant section of research, the laboratories are composed of unit-size rooms, 22ft. by 10ft. 6in., so that the different departments can be moved about or added to at will. Gas, water, steam, compressed air and electric power are all laid on. There are botanical and physics departments and a chemical laboratory.

Botanical Department.—The work of the botanical department is chiefly microscopical, and special means of artificial illumination have been provided for this purpose. The bacteriological laboratory is fireproof and sterilisable. Concrete benches are provided for incubators and sterilisers, and a gas-heated autoclave is mounted under a ventilating hood. Electric power and lighting points are fixed on the walls. The department has a very large number of samples of cultivated and semi-wild varieties of seed cotton, and further material for study is obtained from the experimental greenhouse in the grounds, where about 300 cotton plants can be grown at one time. The greenhouse is a lean-to building, 27ft. by 9ft., specially designed to give the greatest light-receiving area. It is heated by a gas boiler controlled by thermostat valves, so arranged as to maintain a minimum temperature of 60 deg. to 65 deg. Fah. at night or 65 deg. to 70 deg. Fah. by day.

Physics Department.—For the study of the physical and mechanical properties of single cotton hairs, carded cotton, slivers, yarns and fabrics, four rooms are set apart, in which the absence of fixed benches is perhaps a striking feature. The supply lines are arranged at the standard height around the walls, and working tables are placed just where they may be most convenient for the work in progress. Moreover, battens are screwed to the walls at two heights from the floors, and apparatus which is to be mounted for any length of time is attached to these battens. Electric power plugs are provided in each room and also six independent circuits from the special battery. Two of the rooms have concrete floors, paved with wood blocks, so as to secure freedom from vibration when very delicate instruments are in use. The department is fully equipped for physical research, and among the apparatus available are several special appliances which have been

designed by the research staff and made in the workshops of the Institute.

The Chemical Laboratory.—The main chemical laboratory—40ft. by 30ft.—is a room with ample research accommodation for ten or twelve workers. The walls are covered with white tiles up to a height of 8ft., and the remainder will be covered with a special acid-resistant enamel paint. Two large fume cupboards occupy the window spaces at one end, the draught being induced by gas burners placed in the flues at floor level. Furnaces, thermostats and large pieces of apparatus are accommodated on wide concrete shelves with Ruabon tiles, and the usual teak-topped benches include one which is reserved for distillations. Bright metal fittings for gas, water, steam, compressed air, and electric light and power have been entirely avoided on account of their liability to corrosion, and great care has also been taken to ensure that the work of clearing the drainage system or repairing the supply lines shall give the minimum of trouble. The working benches, 27ft. long, are made of pitch pine with teak tops. Large glazed sinks are provided at each end, and the drainage from the taps and permanent metal filter pumps, which range along the benches, is taken by glazed earthenware channels. All the sinks discharge into loose mixing traps before emptying into the drains. The gas and water supplies are conveyed by closed circuits of 2in. pipes, fitted with control valves at each end, and steam is provided at any pressure desired from 5 lb. to 40 lb. per square inch.

The Balance Room.—The sensitive balances which are in constant use by the staff of the departments of chemistry and "colloids" are kept in a room adjacent to the chemical laboratory. They are placed on a substantial shelf mounted on five solid piers rising direct from the foundations, and are thus as free as possible from disturbance by vibration.

Department of Colloid Chemistry and Physics.—Modern views of the nature of the cellulose found in cotton, of the starches used in sizing, and of many dyes tend more and more to lay stress on the necessity of regarding the study of their peculiar properties as a special branch of physical chemistry. The great importance of the subject of "colloids" for the cotton industry has been recognised by the creation of a separate department consisting of three two-unit rooms, having tiled benches along the window sides and narrow shelves around the walls which carry the gas and water pipes and small sinks. The working space is provided by separate tables the same height as the narrow shelves, which are distributed in accordance with the needs of the work in progress. In each of two of the rooms one window space is occupied by a fume cupboard, but the central room is reserved for work which demands freedom from chemical fumes, and it has a concrete floor with wood block surface, to minimise vibration of the instruments used. The large pieces of apparatus, such as incubators, a shaking machine and a centrifuge are placed in the room nearest the main chemical laboratory. Each room is wired for electric power and also for six independent circuits of low voltages from the battery.

Optical and Dark Rooms.—One two-unit room has the roof lights completely obscured, the windows provided with roller blinds, and all the walls, woodwork and furniture painted a dead black. A corner is partitioned off and made accessible from the corridor or from the main room, and this is fitted as a photographic dark-room. Both parts are ventilated by a light-tight electric fan.

The Battery.—For certain experimental purposes, it is necessary to have a supply of electric power at low voltages, which is free from fluctuations. An accumulator battery of twenty 2-volt "Exide" cells, connected in series, has therefore been installed. The capacity of the battery at normal discharge is 396 ampère-hours, the normal rate of discharge being 39 ampères and the maximum rate 94 ampères. Leads at various intervals supply to bus-bars on the discharge board currents at 2, 6, 12, 20, 28 and 40 volts. Charging is done by a 9-kilowatt motor generator at the normal rate of 50 ampères. The generator field coils are externally regulated, allowing the charging voltage to be varied from 0 to 180. It will therefore be possible to charge in series a much larger battery than the present one, or to revive single cells or groups of cells which may at any time become abnormally run down. On the discharge board counter-poised plugs, connected with the laboratory wires, are movable in a vertical plane, whilst the bus-bars are horizontal. It is possible by proper arrangement of the plugs to supply any laboratory circuit with voltages of values from 2 to 40 volts. The switchboard is also fitted with the usual safeguards against overloading of the battery or of any circuit.

The Workshops.—The coach-houses and stables of the estate have been converted into workshops for the construction and repair of instruments used in the laboratories and the general maintenance of the Institute. Ample accommodation has been found for smith's and carpenter's work and general machining downstairs and for a scientific glass-blower above. The engineering shop occupies the main room, and possesses a large range of hand tools and fine measuring appliances, a screw-cutting lathe, an accurate bench lathe, a milling machine, an engraving machine with attachments for making graduated scales, as well as ordinary drills and grinding machines. All the machinery is driven by an electric motor, and the air blast for the smith's forge and brazing furnace and for the glass-blower's use is also electrically induced.

Diesel Machinery for Single-Screw Motor Ships *

By JAMES RICHARDSON.

Notwithstanding the vast increase in the number of ships fitted with internal combustion engines, single-screw motor ships of 2000 tons deadweight and over have hitherto been exceptional. Increasing confidence in the Diesel engine as a reliable and satisfactory prime mover for marine propulsion, and the desire to take advantage of its economies in classes of vessels of low power, where the single-screw arrangement is almost the only one permissible, have recently brought this subject into prominence. In discussing the general problems involved in the application of a single motor in ships of this size it may be helpful to give at the outset details of such a vessel.

Table I.—*M.S. Pinzon.—Particulars of Ship and Machinery.—Description.*

Ship.—Displacement = 3300 tons.
Length = 240ft., breadth = 38ft., depth = 18ft.
Winches.—Six fitted, each 16 horse-power.
Windlass.—One fitted, 50 horse-power.
Main Engine.—Beardmore-Tosi four-cycle, single-acting, six-cylinder, 620 mm. (24⅜in.) bore, 975 mm. (38⅜in.) stroke, 1250 brake horse-power at 120 revolutions per minute.
Main Injection Air Compressors.—Two three-stage. Swept volume per revolution one compressor = 2 cubic feet.
Swept volume per revolution two compressors = 4 cubic feet.
Auxiliary Compressor.—Three-stage. Capacity first speed = 88 cubic feet per minute free air.
Capacity full speed = 176 cubic feet per minute free air.
Emergency Compressor.—Swept volume = 12 cubic feet per minute free air.
Starting Air Receivers.—Three at 70 cubic feet each = 210 cubic feet.
Maximum working pressure 500 lb. per square inch.
Main Engine Blast Bottle.—One working, one spare fitted.
Capacity of one bottle = 5 cubic feet.
Maximum working pressure 1000 lb. per square inch.
Auxiliary Generators.—Two fitted, each 50 kilowatts, Diesel driven.
Engines of trunk piston type, two-cylinder, four-cycle, 75 brake horse-power, 250 revolutions per minute.
Compressors (Auxiliary Generators).—For one generator engine, swept volume of compressor at 250 revolutions per minute. = 41.2 cubic feet per minute free air.
Two generator engine, swept volume of compressor at 250 revolutions per minute = 82.4 cubic feet per minute free air.
Starting Bottle (Auxiliary Generators).—Two per engine capacity = 3.54 cubic feet each.
Maximum pressure 1000 lb. per square inch.
Blast Bottle (Auxiliary Generators).—One per engine capacity = 1 cubic foot each.
Maximum pressure 1000 lb. per square inch.
Propeller.—Diameter = 12ft. 6in., pitch = 11ft.

Table I. gives the leading characteristics of the machinery and equipment of the single-screw motor ship Pinzon, built and engined by William Beardmore and Co., Limited, of Dalmuir.† All deck and engine-room auxiliaries are electrically driven. No boiler is fitted. The total consumption of fuel oil for all purposes in this ship at 9, 10, and 11 knots at sea, fully laden, in reasonably good weather, is 3, 4, and 5.1 tons per day respectively, as given in Table II. The results of the machinery trials are shown

Table II.—*M.S. Pinzon.—Results of Sea Trials.—Fuel Consumption per Day (in Tons) for all Purposes.*

Speed of ship (fully laden), knots	9	10	11
Revolutions per minute (main engines)	95	105	115
Fuel consumption, all purposes (tons per day)	3	4	5.2

in the cylinder head can be rotated on their seats by hand.

(4) All the main parts, including pistons, must be completely accessible.

(5) The failure of any one or two fuel pumps, supplying fuel under pressure to the main cylinders, must not necessitate a stoppage.

(6) The subject of main engine flexibility, the manœuvring gear, valve setting, and the proportioning of the flywheel, and the whole question of starting or manœuvring air supply must have greater attention than in the case of a twin-engined vessel.

(7) The engine shall be capable of being readily manœuvred by one operator.

As with steam installations, so with motor machinery; the subject of the auxiliaries, both deck and engine-room, is only now receiving the attention demanded by its vital importance. With motor ships the rival claims of an electric or steam drive still form, and are likely to continue to prove, debatable ground. The alternative of an electric engine-room and steam-driven deck machinery is possible and may commend itself in certain cases. In Table III.

Table III.—*M.S. Pinzon and Similar Steamship.—Comparison of Fuel Consumptions at Sea and in Port.*

Steamship.
Triple-expansion engines, single screw.
Ship, 270ft. by 38ft. by 18ft.; draught, 17ft. 5in.
Voyage, London to Spanish port.
Indicated horse-power, 1073.
Revolutions per minute, 75.8.
Speed of vessel, 9.35 knots.
Coal used per day for all purposes, 17.42 tons.
Coal used by auxiliaries per day, 2.5 tons.
Coal used in port per day, discharging and loading, 3 tons.
Banked fires, used per day, sixteen days on average voyage, 1 ton.

Motor Ship Pinzon.
Diesel engines, single screw.
Ship, 240ft. by 38ft. by 18ft.; draught, 17ft. 6in.
Voyage, Glasgow to Spanish ports.
Diesel indicated horse-power, 1290.
Equivalent steam indicated horse-power, 1170.
Revolutions per minute, 106.
Speed of vessel, 10.2 knots.
Oil used per day for all purposes, 4.5 tons.
Oil used by auxiliaries per day, 0.2 ton.
Oil used in port per day, discharging and loading, 0.37 ton.

is given a comparison of the consumption of fuel in similar vessels, one a steamer and the other a motor ship, on the same trade. The total consumption of coal is five times that of oil (by weight) in the latter taken over a whole voyage, and is achieved by the utilisation of all electric machinary for deck and engine-room auxiliaries, deriving current from Diesel-driven auxiliaries. With steam auxiliaries on the motor ship, on this trade, the fuel consumption would only be one-third (not one-fifth) that of the steamship.

Table III. emphasises clearly the importance in a steamer

FIG. 1—INDICATOR CARDS TAKEN DURING SPEED TRIALS OF THE MOTOR SHIP PINZON

by the curves in Fig. 2, and the main engine indicator diagrams are reproduced in Fig. 1. In connection with the diagrams, attention may be directed to two points. First, the very flat fuel consumption curve which lies below 0.5 lb. per brake horse-power per hour for the main engines, for speeds from a maximum of 125 revolutions per minute to 81 revolutions per minute, *i.e.*, from over 1400 brake horse-power to 420 brake horse-power. Secondly, an inspection of all the indicator cards shows from the toe of the diagram the very rapid release of the exhaust gases. The pressure drops to atmospheric almost before the bottom dead centre is passed. This result is due to the large valve areas possible with the well-known Tosi arrangement of combined inlet and exhaust valves with the director valve controlling the exhaust gases and induction air. A further feature of this system is the extremely low exhaust temperatures, which never exceed 500 deg. Fah., although measured in the stream of the gases in the cylinder head.

Broadly stated, above 7000 tons deadweight and 11 knots speed there is a good case for the retention of the standard twin-screw arrangement of oil engines because of the lower total cost, the reduced weight of machinery, the shorter length of engine-room, which compensates for the cargo space taken up by the extra shaft tunnel, and the reduced risks of breakdown. The *personnel*, however, is increased.

Turning in detail to the problems inherent to single-screw Diesel machinery, it may be said first that the dictates of reliability and the limited man power available on board demand that certain operations shall be made possible and certain conditions fulfilled.

(1) The crank shaft shall be capable of being removed and replaced with the minimum dismantling of the main engine parts. As an alternative, the after length of the crank shaft, being the more liable to breakdown, shall be so accessible that it can be readily removed and replaced.

(2) That part of the fuel injection air service common to all the main engine cylinders should be in duplicate, including the blast bottle, so that failure of any pipe, joint, valve or chest, &c., shall not necessitate, at most, more than a momentary stoppage.

(3) Arrangements must be made so that all the valves of the fuel consumption attributable to the auxiliaries generally, and in such conditions as in a coasting trade, in particular, the fuel consumption of the deck machinery. Whereas at sea the ratio of coal to oil for all purposes is 4 to 1, in port this ratio is over 10 to 1 if fires are "banked." A small oil-fired boiler is generally required for the heating of the accommodation and of the oil fuel, although the former can be carried out by electric radiators, and if only a small quantity of oil is carried exhaust gases can be utilised for heating it. There is probability of the general adoption in future of a reasonable utilisation of waste heat with Diesel marine installations, whereby oil fuel and accommodation heating can be carried out entirely by the main engine exhausts when at sea and partially, at any rate, by the auxiliary exhausts when in port. The subdivision of the requisite total Diesel electric generator capacity and the desirable margin to be legislated for is an interesting point. Sometimes two generator engines and in a number of twin-screw ships four have been fitted. The actual electric loads on the M.S. Pinzon under various conditions have been tabulated and the load in kilowatts on the auxiliary Diesel generators may be summarised as follows:—Normal sea load: maximum, 59.85; minimum, 23.2; manœuvring load: maximum, 151.25; minimum, 46.85; port load: maximum, 72.2; minimum, 22.6. In general, three sets are preferred, one to be in action normally at sea and in port and two when manœuvring or working cargo fully, one serving as a stand-by. Three such sets of 50 kilowatts each meet the case shown in the table, and only rarely does the minimum load fall substantially below half the power of one unit, a proportion desirable for good working conditions with such machines.

The manœuvring load is the highest, even when it may be arranged that the auxiliary compressor is slowed down if and when the windlass load comes on, and that the radiators may be cut out if necessary. The manœuvring load comes within the capacity of two generators. The greatest individual load is the auxiliary compressor required to make up starting air. This machine is of sufficient capacity to supply the main engine with injection air at full power in emergency, should both the main engine-driven injection compressors be out of action.

The conservation and replenishment of starting air is a subject of vital importance with internal combustion machinery, as the ability to manœuvre the ship is lost if a

* Institution of Naval Architects. Abstract.

† See The Engineer, February 10th, 1922.

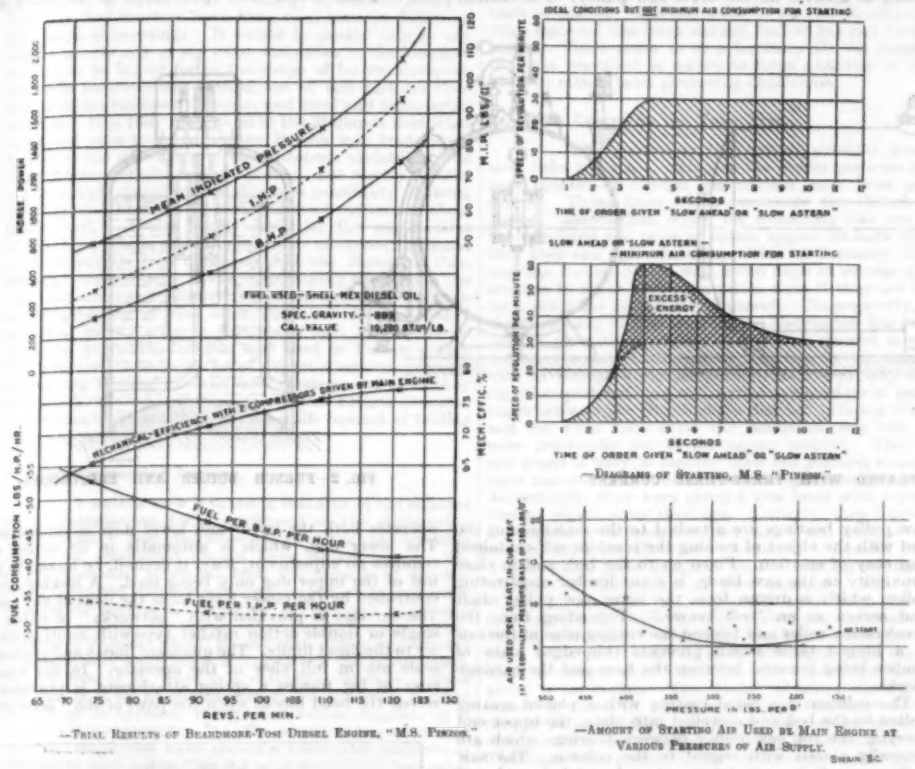
sufficient quantity and pressure of air is not always available to start the main engine. Apart from the subject of conservation, reasonably rapid replenishment must be arranged for, as it is possible for a large quantity of air to be lost, as, for instance :—

(i) If the exhaust valve of the cylinder into which starting air is being admitted should be hung open ;

(ii) If one or more starting air valves in the cylinder head hang open ;

(iii) Or if the engine manœuvring gear should jamb in the six or three cylinders on air position and other means not be immediately adopted to shut off the air.

As an example of the demand made upon the starting



—Trial Results of Beardmore-Tosi Diesel Engine, "M.S. Pinzon."

IDEAL CONDITIONS BUT NOT MINIMUM AIR CONSUMPTION FOR STARTING
SPEED OF REVOLUTION PER MINUTE
SECONDS
TIME OF ORDER GIVEN "SLOW AHEAD" OR "SLOW astern"
SLOW AHEAD OR "SLOW ASTERN" —MINIMUM AIR CONSUMPTION FOR STARTING
EXCESS ENERGY
SECONDS
TIME OF ORDER GIVEN "SLOW AHEAD" OR "SLOW ASTERN"

—Diagrams of Starting, M.S. "Pinzon."

—Amount of Starting Air Used by Main Engine at Various Pressures of Air Supply.

Swain Sc.

FIG. 2—CURVES SHOWING PERFORMANCE OF PROPELLING MACHINERY OF THE PINZON

air storage capacity, two extracts from the log of the M.S. Pinzon is given (Table IV.) when entering Dalmuir

TABLE IV.—*M.S. Pinzon.—Copy of Log of Engine Telegraph Orders Carried Out on January 13th, 1922, Entering Dalmuir Basin.*

	p.m.		p.m.
Half ahead	4.37	Stop	6.05
Slow ahead	4.50	Slow ahead	6.1
Half ahead	5.4	Stop	6.2
Slow ahead	5.12	Slow ahead	6.4
Stop	5.14	Stop	6.4.5
Slow ahead	5.15	Slow ahead	6.5
Half ahead	5.20	Stop	6.5.1
Slow ahead	5.20.5	Slow astern	6.5.5
Half ahead	5.37	Full astern	6.6
Slow ahead	5.40	Slow astern	6.6.5
Stop	5.46	Stop	6.7
Slow ahead	5.47	Slow ahead	6.7.1
Stop	5.48	Slow astern	6.7.2
Full astern	5.48.5	Full astern	6.7.5
Slow astern	5.50	Slow astern	6.7.5
Ahead slow	5.51	Stop	6.7.6
Full astern	5.51.5	Slow ahead	6.7.7
Slow astern	5.52	Stop	6.8
Stop	5.52.5	Slow astern	6.8.5
Full astern	5.53	Stop	6.8.6
Slow astern	5.53.1	Half astern	6.9
Stop	5.53.5	Slow astern	6.9.1
Astern slow	5.54	Stop	6.9.2
Stop	5.54.5	Slow ahead	6.9.5
Astern slow	5.55	Stop	6.10
Stop	5.55.5	Slow ahead	6.12
Slow ahead	5.56	Stop	6.12.5
Stop	5.59	Finished with engines	6.15
Slow astern	6.0		

Basin. There is one characteristic of these extracts and similar entries in the log to which reference might be made, and that is the prevalence of the repetition of the *motif*, "slow ahead, stop, slow ahead, stop," having the effect of propelling the ship by repeated thrusts rather than by a sustained effort. It might be suggested that the minimum sustained power possible with the main Diesel engine is excessive. This is not so. The engine has been run for considerable periods at 24 revolutions per minute corresponding to a maximum speed through the water of 2.5 knots, when full way has been obtained, and a piston speed of 150ft. per minute, giving a ratio of maximum to minimum piston speed, or speed of revolution of 122.5/24 or 5.2 to 1. It is difficult to foresee any substantial improvement upon this result, since regular firing of the very minute charges of oil fuel can hardly be expected at a lower piston speed without some substantial increase in complication, as would be involved, for instance, by preheating the induction air. This extremely and exceptionally low speed of piston of 150ft. per minute is attained by correct combustion-producing means and by the fitting of a fly-wheel with suitable momentum effect.

As is now recognised by Lloyd's Register, the fitting of a fully proportioned fly-wheel isolates the thrust, intermediate and propeller shafts from the variation of engine turning moment. The crank shaft is also equally protected from shocks, which might otherwise be transmitted from the propeller. Such a fly-wheel has no deleterious effects when starting up or reversing. Momentum is first given by an elastic medium—compressed air—and during a sudden reversal which can be carried out in less than ten seconds, with full way on the ship, the starting air on being admitted astern, if the engine compression has not already brought the engine to a stop, gently pulls the engine up and gives the initial impulses in the opposite direction.

The two diagrams reproduced in the right hand top corner of Fig. 2 show clearly the only remaining justification with modern Diesel engines for the charge of lack of flexibility. When starting up, especially with a view to doing so on the minimum expenditure of compressed air, fuel injection is commenced early, and the engine accelerates to "half speed" before retarding to "slow." The total amount of impulse given to the ship is, therefore, approximately twice the ideal. The reconciliation, therefore, of the two somewhat conflicting aims of minimum compressed air used and minimum speed of revolution during starting, without undue complication of the manœuvring gear, is worthy of close study.

It will be found with every type of engine that there is a pressure of compressed air most suitable for starting with the minimum expenditure of air storage energy.

The bottom right hand curve given in Fig. 2 shows that with pressure between 250 lb. and 350 lb. per square inch the loss of air is a minimum. Whatever the storage pressure—500 lb. per square inch with the Pinzon—a reducing valve to ensure that the pressure on the engine side of the air supply is not greater than 350 lb. per square inch, or other means such as working on one of a number of reservoirs, will facilitate the conservation of air.

To consider the replenishment of the storage, Appendix I. gives data obtained. Making the assumption that one start per minute will be the maximum required, over any appreciable length of time, and as the receivers fitted have a capacity of forty starts without re-charging—which will cover any exceptional number of starts called for during a short period—it is shown, and has been proved in practice, that :—(1) Neglecting the excess injection air from the main engine, amounting to 2 cubic feet of free air per revolution of the main engine, there is available air storage and means for replenishment capable of sustaining one manœuvre per minute continuously. (2) If the main engine makes 75 revolutions each move, its excess injection air on being tapped off to the starting bottles will restore what has been taken for the start.

Analysing a number of logs of "stand-bys," it is found that the average of one manœuvre per minute is not exceeded. The average "move," however, is of much less than seventy-five revolutions, so that actual conditions are a combination of (1) and (2) above, but condition (1) must be satisfied in order :—

(*a*) To give a stand-by in case of breakdown, with the main engine injection compressors.

(*b*) To cope with the demands for air for starting during a short spell of manœuvring, calling for more than one move per minute, if air has been lost for any reason.

(*c*) To supply starting air when the main engine injection compressor is either out of action or is working inefficiently and giving no excess air to the starting receivers.

The starting and reversing of an engine operating on the four-cycle principle have been brought to the simplest terms, consistent with operation from the usual starting platform. Whatever may be permissible with a twin-screw ship, it is considered essential with a single-screw installation that the controls should be on the engine-room floor level, and the major portion of the gear serves to bring the controls to the usual location. Single-screw Diesel machinery for the average cargo carrier will be much developed in the near future, and the lines of design which will be followed will tend decreasingly to demand a compromise between the best propeller and a smaller and more compact engine, especially with the larger ships. Speeds of revolution will become standardised as with the steam engine, and longer stroke engines will be built. The weight of machinery, the space occupied and the cost will be greater, which will be more than compensated for by the extra accessibility, a built-up crank shaft and a considerably better average propeller performance.

APPENDIX.

M.S. Pinzon.—Data Relating to Compressed Air—Time to Start from Conditionally "No Air in Ship."

(*a*) When running the emergency compressor of 12 cubic feet per minute swept volume.

Time to fill one blast bottle and one starting bottle for auxiliary generator engine to
800 lb. per square inch = 26 min. 50 sec.
1000 lb. per square inch = 35 min. 30 sec.

(*b*) When running the auxiliary compressor.

Time to fill one starting air reservoir to 500 lb. per square inch = 19.5 min.

Additional time to top up one blast bottle from 500 lb. to 1000 lb. per square inch = 2.5 min.

(*c*) Air available when manœuvring main engine.

Air from one main engine-driven compressor—the other being sufficient for blast supply = 2 cubic feet per revolution.

Excess air from auxiliary engines (estimated at one-third of air made) = 27.5 cubic feet per minute.

From auxiliary compressor = 176 cubic feet.

(*d*) Assuming no air is taken from main compressors, we have 174 cubic feet free air per minute available. This is equivalent to approximately 7 cubic feet air at 350 lb. per square inch per minute. The main engine uses from 5 to 7 cubic feet of air at 350 lb. per square inch per start or reversal, so that there is sufficient air available to allow of one manœuvre per minute continuously, neglecting any surplus air made by main engine.

(*e*) 70–75 revolutions of main engine supply air for each manœuvre (one compressor used wholly for blast), so that if the main engine is allowed to make 75 revolutions for every manœuvre the starting air can be maintained by the main engine without using any auxiliary supply.

CATALOGUES.

BRITISH ENGINE, BOILER AND ELECTRICAL INSURANCE COMPANY, Limited, 24, Fennel-street, Manchester.—Pamphlet on breakdown of electrical plant.

ATELIERS DE CONSTRUCTION ELECTRIQUES DE CHARLEROI, 56, Victoria-street, S.W. 1.—A copy of the *A.C.E.C. Bulletin*. This *Bulletin* appears for the first time since the war started. A copy of the April stock list.

ARCHIBALD D. DAWNAY AND SONS, Limited, Steelworks-road, Battersea, S.W. 11.—Handbook of constructional steel work. The book consists of about seventy pages of closely printed information of great use to architects and others engaged in the building and engineering trades. It is of such a size that it will slip into the waistcoat pocket.

EDGAR ALLEN AND CO., Limited, Imperial Steel Works, Sheffield.—We have received a copy of the firm's booklet, entitled "Edgar Allen's High-speed Steels." Much useful information has been embodied in the book, and contains the latest information on the subject. The use of high-speed steel and their heat treatment, with many other details, is included.

ALTON BATTERY COMPANY, Limited, Alton, Hants.—A copy of the firm's latest catalogue on accumulators for all purposes. Much interest has been shown recently regarding storage batteries for home lighting and small power installations, and this catalogue is the result of these inquiries. Illustrations of plants, with diagrams, are embodied in the catalogue, which is on the loose-leaf principle.

A. P. LUNDBERG AND SONS, Pioneer Electrical Works, 477–489, Liverpool-road, Holloway, N. 7.—The seventh edition of "Lektrik Lighting Connections" is just published. This book is in handy form and may be carried in the pocket. Where any wiring is to be carried out the little book may be consulted with confidence. The edition is revised and enlarged. Many useful diagrams have been included.

LOCOMOTIVE NEWS AND RAILWAY CONTRACTOR, 154–5–6, Finsbury Pavement House, E.C. 2.—A copy of the above mentioned publication, dated January 10th, is to hand. This issue constitutes No. 1 of a new series, and we understand that the subject of "Railway Contracting" is to receive special attention. The paper is issued fortnightly and reliable news of locomotives and railway engineering progress is dealt with.

CROMPTON AND CO., Limited, Chelmsford.—Leaflet No. 605. Crompton's patent self-starting synchronising polyphase motors have been constructed in large numbers and sizes up to 800 brake horse-power are successfully operated. The firm has received a large number of orders for this type of motor. In addition to illustrations of the machines, a general arrangement diagram of connections has been included in the leaflet.

SIR W. G. ARMSTRONG, WHITWORTH AND CO., Limited, 8, Great George-street, S.W. 1.—List of special refined pig for cast iron foundries, manufactured by the firm at Close Works, Gateshead. The number of the brochure is No. 167, which may be obtained with prices on application to the firm. Brochure No. 109 illustrates and describes the A.W. pneumatic coal pick. This is a list of part numbers for sizes 5 and 6. All spare parts are stamped with a series number for convenience when ordering. Brochure No. 112 treats with the A.W. pneumatic boiler scaler. A sectional view is given of the scaler, and all spare parts are numbered. Both these tools have just been put on the market by the firm.

CRYSTAL PALACE SCHOOL OF ENGINEERING.—The Crystal Palace School of Engineering is this year celebrating its jubilee, and on the 11th inst. Lord Headley, a past-president of the Society of Engineers, addressed the students and presented the certificates. He had, he said, been agreeably surprised at the excellence of the students' work. He had no idea anything could be turned out so accurately and neatly. Cleverness was no good without principle, and learning was of no good without common sense to apply that learning. He quoted instances of assistants under him failing because they were not suited to the occupation they took up. British workmen, he continued, were to-day trying to do as little work as possible and to screw out the highest wages. This was not cricket. The nation was not producing what it should do. Exports were going down, and in consequence all were being hit. He strongly condemned limitation of output by trade unions. The "Wilson Premium" for the best paper read before the Schools Engineering Society during the past session was handed to Mr. W. Hamilton for his paper on "The Port of Calcutta." Other papers read before the Society during the session were :—"The Classification and Uses of Coal," by C. G. B. Wall, and "Mechanical Road Traction," by R. S. L. Lee.

Surplus Electrical Energy for Steam Production.

CONTINENTAL engineers have given considerable attention to the problem of the electric steam boiler, both as a steam producer for industrial process work and as a means whereby surplus electrical energy may be economically used. In our issue of October 14th we described in detail a boiler of French design, used in connection with the paper-making industry. We give in what follows some particulars of another large boiler which was recently described in the German technical Press.

Made by the Wärme-Akkumulatoren-Gesellschaft, of Berlin, this boiler was specially designed to utilise surplus current during the night and at other light-load periods, the steam generated being supplied to a battery of cellulose digesters at a pressure of from 49-50 lb. per square inch. The boiler illustrated in Fig. 1 is of 6000 kilowatts capacity, and was designed to work with three-phase current at a pressure of 6000 volts. Such a boiler may be attached to an already existing battery of coal or oil-fired boilers, its purpose being to utilise automatically any surplus energy that may be available in the network from which the electrical supply is taken. Thus, if supply is drawn from a power station with a combined power and lighting load, the boiler will take up automatically the difference in load between the sum of the lighting and power loads and the full-load capacity of the plant. This is made possible by altering the level of the water in the boiler within very small limits to suit any change in load. With this method of regulation all moving parts inside the boiler are avoided and the complete control arrangements, as shown, are mounted on the outside.

With the type of electrode used in the French boiler, similar to that shown in Fig. 2, regulation is only possible to suit the load on the boiler, and does not take into account the surplus energy available. The disadvantages of this type of electrode are that, particularly with small boilers, there being no feed control, phase disturbances are likely to be caused, which may cause flickering in the lamps on the adjoining lighting circuits. Eddies also are frequently set up round the electrodes, which in such case are often alternately laid bare and then quickly covered with water, causing unequal loading.

Quartz insulation has been tried for these electrodes, but it has been found that in spite of its very low expansion coefficient and its insensibility to temperature changes, it does not answer well. It is much more brittle than porcelain, and is quickly corroded by boiler water. In the boiler described the type of electrode used is not influenced by the specific conductivity of the water within wide limits, and all kinds of water, including chemically purified water, may be used.

As will be seen from the drawing given above, the boiler may be built in the horizontal form, which has the advantage of a larger surface for steam raising. The boiler is so arranged that when steaming, either full-load current or overload current may be used.

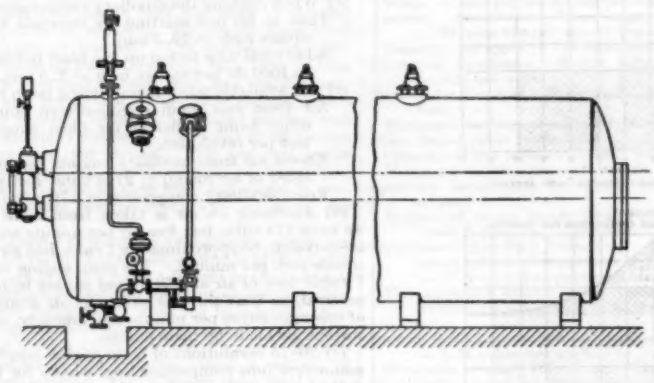


FIG. 1—BOILER OPERATED WITH THREE-PHASE CURRENT

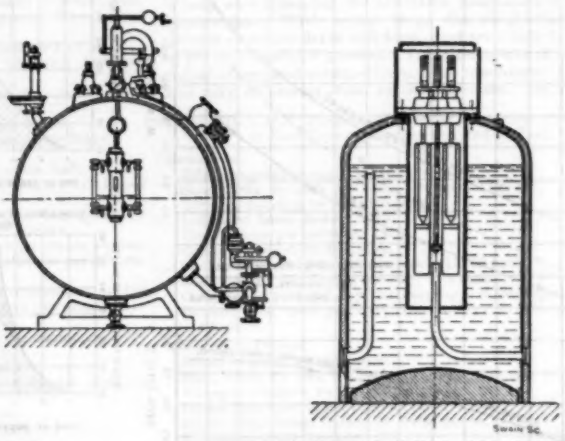


FIG. 2—FRENCH BOILER AND ELECTRODES

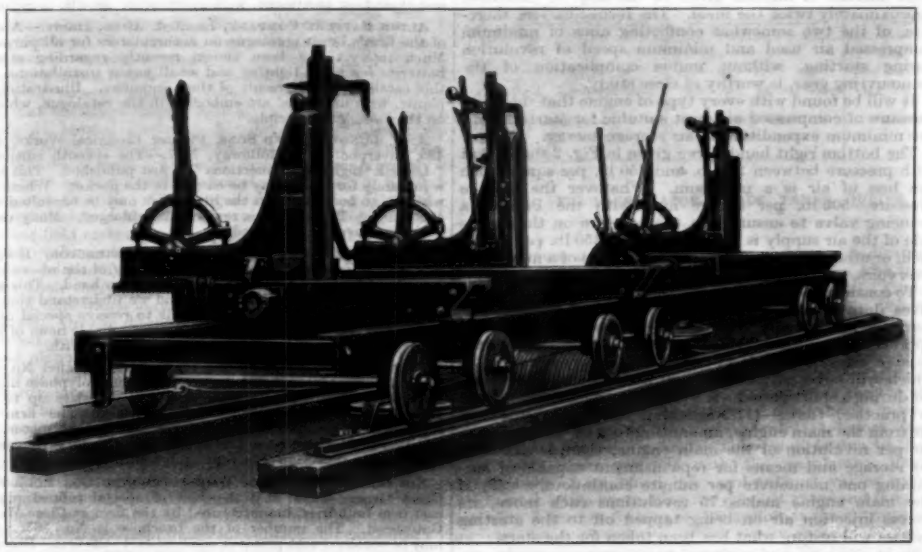
Vertical Log Band Mill and Carriage

THE accompanying engravings represent a vertical log band mill and log carriage, made by John Pickles and Son, of Hebden Bridge, which embrace several recent improvements. The base, or bed, which is of strong box section, forms a support for the column and wheels, as well as acting as a cover for the lower saw pulley. The bottom saw pulley bearings are attached to the underside of the bed with the object of making the machine self-contained and easy of erection. Fixed on to the bed, and in close proximity to the saw blade, is a cut lumber accelerating roller, which is driven from the lower saw pulley shaft and serves as an "off bearer." Extending from the accelerating roller and beyond the cutting edge of the saw is a hinged table which prevents thin edged slabs of timber being jammed between the base and the carriage blocks.

The column is a cored casting with a planed seating bolted to the bed and dowelled into place, the upper end carrying the top saw pulley between bearings which are centrally placed with regard to the column. The saw pulleys are first accurately machined and balanced and their faces are then ground true while they are running on their own shafts at full speed. The lower pulley is solid, and has a heavy rim and splayed plate designed to give a fly-wheel effect, to prevent over running of the top pulley and thus to lessen the risk of saw breakages. All the bearings for these shafts are of the ball or roller dust-proof self-aligning pattern.

The straining device for the saw blade embraces new features, the chief of which is the means for enabling the top pulley bearings to be balanced on knife edges with a spring cushioning appliance. This provides an elastic medium for responding quickly to changes of tension on the blade. The "straining" of the saw is effected by raising the upper wheel by means of the screw and worm wheel gear and hand wheel shown in the illustration. A simple adjusting mechanism is also fitted to regulate the "cross lining" of the saw. The upper saw guide is of improved design to admit of easy access when changing saws. For this purpose it is secured to an arm which is pivoted on a bracket attached to the column. This arrangement enables the guide to swing clear should the log strike the guide when being fed into the machine, the design being such that, on the obstruction passing clear, the guide swings backward again, by its own weight, to the correct sawing position. The lower guide has also a special feature, being connected with a lever for opening its jaws and thus enabling any residue to fall clear. This lever, it may be explained, is operated by the sawyer.

The log carriage, which is built up of steel sections, is mounted on wheels and axles which run on planed steel rails. The carriage is designed to be operated either by cable, rope, or rack and pinion. The head blocks are of steel, and consist of a steel base, with reversible steel facing plates and roller bearings for the "set shaft." A strong cast steel knee extends well back to give a long bearing support, and there is a taper setting adjustment to suit crooked logs. The head blocks have rack movement, and each is provided with a double "dogging" arrangement, by means of which both dogs are operated by one power lever. After setting the upper dog tooth in the required position and locking it to the side bar by means of its ball weighted lever, the "power" lever is pulled and operates both the upper and lower dogs simultaneously. The lower dog, which is automatic in its action and requires no adjustment, may, if desired, be locked to permit of the upper dog only being used. A locking device controlled by the power lever locks the dogs at any point. The carriage is provided with "setworks" of either the single or double action ratchet type with multi-pawls to set to the finest limits. The quadrant, index and graduated scale are in full view of the operator. In the smaller sizes of log frames a spring attachment is provided to recede the head blocks when the pawl of the "setworks" is released by the lever provided for the purpose. A brake arrangement is provided in conjunction with the lever to prevent shock when the knees are drawn back. For the larger sizes of log carriages the setting and receding is facilitated by a continuous rope drive available when the carriage is either stationary or in motion, two levers only being required for setting or receding all the knees simultaneously.



LOG CARRIAGE FOR BAND SAW MILL

PICKLES LOG BAND SAW

AN important decision for railway companies was given by Mr. Justice Lush in a case against the South-Eastern and Chatham Joint Managing Committee. At a level crossing the large gates were worked from an adjacent signal-box, and the wicket gates were controlled therefrom, and the signalman thereby fastened the latter gates against pedestrians when a train was approaching. The plaintiff found the wicket free and passed on to the line and was caught by a train. The man lived in the neighbourhood, and so knew that the wickets should be locked when a train was approaching, and his Lordship came to the conclusion that to find them free was a tacit invitation to enter on the line, and he gave the man £550 damages and costs. We would point out that the control of wicket gates is not a requirement of Parliament or the Ministry of Transport, but a voluntary act of the railway companies to avoid accidents.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Genoa Conference and the Iron Trade.

WHILE the general condition of the iron trade in this part of the kingdom continues decidedly unhappy and unsatisfactory, it is pleasing to notice the hopefulness with which iron and steel masters locally regard the proceedings at Genoa. This week, when there has been little in the way of direct trade to engage attention, Midland iron and steel masters have been very keen on following the Genoa proceedings. It would be pretty safe to say that in hardly any of the other industries in the kingdom is more to be hoped for in the shape of future European economic improvement arising out of this historic Conference than attaches to the iron and steel and engineering interests. It is fully recognised in the Midlands that what is wanted once more to set the British iron trade upon its feet is the stabilising of the European exchanges. So long as these remain in their present, not merely erratic, but well-nigh despairing condition, a possibility of doing a continental business in iron and steel matters is absolutely "off." I can hardly say that the negotiations of the thirty European nations, have converted Midland trade pessimists into optimists, but the European Conference is undoubtedly having a reassuring effect upon our manufacturers, and I firmly believe the future will witness a strengthening of this more confident feeling. As I remarked in my letter a few weeks ago, the enormous increased production of iron and steel in France during the past year has aroused almost a spirit of serious covetousness among Midland iron and steel masters, and what they now say is wanted is that some of these French executed orders should be reaching British mills instead of finding their way entirely to our French Ally.

The Engineering Impasse.

A serious view is taken in this area of the collapse of the negotiations for a settlement of the engineering trade dispute. Disappointment is great that the laudable efforts for settlement should have broken down. On several occasions there has been full promise of success, and it is trusted this fact will urge the parties to seek fresh avenues of approach. Whether or not the postponed lock-out notices will come into operation, and when, remains to be seen. But it is clear that, unless a settlement is reached very soon, the A.E.U. lock-out will be extended. On the face of it, there is a complete deadlock. None the less, it is by no means certain the situation is quite as bad as it appears, though the omens suggest, it is feared, a long struggle. It is the considered opinion here that the employers have shown a reasonable attitude in offering to give notice "as far as possible" of "material alterations." But that is very different from the acceptance of conditions which might have involved the holding up of important work and interference with managerial authority. It is recognised that the time has come to end all the artificial conditions which prevailed during the war. Irksome restrictions or dictation cannot longer be tolerated, and it is clear that existing laws are adequate for the prevention of any injustice to workers. During the leisure which the Easter holidays has afforded, there has been some quiet thinking on the ill effects of these disputes on trade at this period, and it is recognised that were it not for such eruptions there would be prospects of a trade revival. Manufacturers generally have made a determined fight for the restoration of the varied activities of the nation, and with absolute unity of aim, there would be every prospect of their success. It is hoped therefore it will be proved eventually that the long conference has not been wholly futile, and that a way out of the *impasse* will speedily be found.

Coventry Trade "Boom."

The engineers' lock-out notwithstanding, Coventry is enjoying what may be described as a "boom" in the cycle and motor trade. This happy state of affairs necessarily applies chiefly to the non-federated firms which have been working at high pressure for some time. Contrary to expectation, none of the Federated establishments has closed its doors up to the time of writing. The A.E.U. lock-out is now in its sixth week, but one finds after exhaustive inquiries that the Federated shops are progressing, and still giving output, notwithstanding the absence of the A.E.U. workpeople. This is surprising, and at the same time satisfactory, when one remembers the general unsettlement of such a prolonged lock-out upon a city of circumscribed facilities in the way of general trade.

Raw Iron Trade Revival.

Notwithstanding that there is no increase in the pig iron production in South Staffordshire and East Worcestershire, it is a most satisfactory feature that the number of furnaces throughout the kingdom in blast at the end of March was 107, which is only two fewer than before the coal stoppage last year. Pig iron production last month reached 389,000 tons, which is higher than March last year, and higher than any intervening month. There has been an almost continuous upward movement in production for some months past. These figures argue incontestably that whatever the state of the pig iron trade in Staffordshire is at date, a revival is occurring in some, and perhaps several, other parts of the kingdom in the raw iron markets. The figures have attracted considerable attention in this district, and have furnished a very favourable topic for comment during the holidays. Makers of pig iron are firm in their prices, not only because the output is being disposed of, but on account of the general expectation that better prices will be obtainable whenever the engineering lock-out terminates. Moreover, pig iron has depreciated in Staffordshire, Derbyshire and Northamptonshire more pronouncedly than in the North of England. There are promising developments in the shape of offers, truly in isolated cases, of three months' contracts for some Derbyshire brands of foundry iron. Smelters are, however, very careful with regard to long contracts, and are not disposed to take them on the present basis. Though consumers and merchants are only prepared to buy forward in exceptional cases, some fairly large purchases of foundry iron for prompt delivery have been made. Stocks have been allowed to run low, and precautions are being taken against a squeeze. It is just possible that with industrial peace assured, the market would experience a rebound from the losing prices at which producers have been compelled to sell. Coke prices are firm, and a fair amount of buying is going on by engineers, foundrymen and others who realise that prices are not likely to fall lower in the future. A few of the Derbyshire furnaces still quote 85s. for No. 3 foundry iron, but most of the business put through rules on the basis of 82s. 6d. The quotation of 80s. for Northamptonshire material has been shaded, but it has not been displaced. There seems to be a tendency for the stagnation that has prevailed in regard to forge qualities of iron to yield to rather more promising conditions.

Price Control in the Tube Trade.

Price control in the British wrought iron and steel tube trade has, owing to the severe pressure during past months of foreign competition, now been put an end to. Those firms which constitute the British Tube Makers' Association, which for something like ten years has regulated the price of tubes, appear to have decided that they can fight the competition of Germany, Canada and the United States with more hope of success if they are free to make their own prices than if they are bound by a price list collectively declared. Consequently, from the beginning of this month the Association has had no part in prescribing selling rates This district is one of the chief centres in the whole kingdom for the manufacture of wrought iron and steel tubes, especially of the superior qualities, and the matter is therefore of peculiar importance to the Birmingham district. During the war, and for some time after the Armistice, our own mills were practically out of the export market. They have not found it easy to recover their old position since they have had freer facilities for cultivating the overseas trade. Accordingly, they were given a free hand with regard to foreign orders some time ago. Latterly, they have been threatened with invasion from the West, and, to a less extent, from the European Continent. Canada, in particular, made great progress, and is bidding strongly for business in Australia and New Zealand. The quality of the tube turned out, especially by a large Canadian syndicate, has made a very favourable impression on British merchants. Now that the home trade has been freed from price control, there are signs that the long spell of comparative silence in the order department is about to be broken The freeing of prices was followed, almost at once, by many inquiries in the Black Country for the home market and for export, orders being anticipated from the Continent, South America and India. There has been a very distinct quickening of business, the inference being that tube manufacturers in this area have lost no time in making use of their new freedom, and that they have booked business at prices more in accordance with buyers' ideas of current values than those which formerly ruled.

Manufactured Iron.

The position in the manufactured iron trade of Staffordshire and the Midlands has not been materially altered, or brightened, by the recent quarterly meeting, and the stagnation in the Black Country is practically unrelieved, though here and there, it is stated, there are faint signs of improvement. A change for the better is not looked for until the engineering dispute has been settled. There has been a further drop of 2s. 6d. per ton in common bar iron as the result of the reduction in marked bars. The few other price changes that have taken effect illustrate the downward tendency of the market. Prices have been cut rather severely lately, and this week ordinary bars have been sold at the Scotch level of £11, a price which makers complain involves them in actual loss. Nut and bolt qualities, for which there is not much demand, can be bought at £10 5s. and fencing sorts at £10 10s. Iron gas tube strip is selling at £11 10s., a price which can hardly be remunerative. Little, however, is being called for in view of the much cheaper price of steel material, which can be secured for £10 5s. to £10 10s.

Business in Steel.

The firmness of prices in the steel market is maintained, and business is stated to be fairly satisfactory. Certain steel works continue busy, Hickmans, Limited, of Bilston, for example, consuming the production of their four blast-furnaces. The prices of steel billets are firmer at £7 15s. Some steel firms will not accept lower than £8. In finished bars also, while it is possible to buy at £9 10s., some large local firms will not take lower than £10. Staffordshire steel hoops are easier at £11 15s. This is a reduction of 5s. on the week. Lancashire mills offer hoops for shipment at £11 7s. 6d. f.o.b. For baling hoops they want £14. Wire rods have been offered in some cases as low as £10 per ton, which is £1 10s. below the price quoted by the majority of the makers. There is not much competition in steel from abroad, an exception being the receipt this week by a large Birmingham consumer of quotations for Belgian joints at £7 15s. f.o.b. Antwerp. This would cost £9 5s. in Birmingham, as against the home price of £10 10s., but the material would not be accepted for many British requirements, in which compliance with standard specifications is considered essential.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

Iron and Steel.

THERE are very few members of the iron and metal trades attending to business this week, and, of course, little business to be attended to were they here. Until the engineers are back at work there cannot be much activity in this district, even were the holidays not recognised; but this year things are recognised more strenuously than is usual. Very little notice had been taken up to this week of the incipient trouble in the cotton trade, but there seems now to be some apprehension that this may not be settled amicably. However, as there is only a matter of 20 per cent. between the disputants, one cannot believe that either party will be so mad as to bring about a stoppage for this comparative trifle. We certainly shall not believe in a cotton strike until we see it. Trade is bad enough without this additional piece of folly.

Metals.

The little spurt in standard copper seems to have subsided again, although one must keep in mind the fact that it could scarcely develop this week, even if it means to develop in the future. One has, however, acquired a habit of disbelieving in these short upward movements simply because they have occurred so often, and have always ended in the checking of buying by the consumer. In former times this buying by the consumer was almost invariably stimulated when a rise in prices took place; that is to say, that consumptive buying was always better in a rising than in a falling market; but this does not seem now to be the case. In Manchester, which is the centre of a vast engineering industry, of course, we must make allowance for the lock-out; but even in America an attempt to put up the price of copper at once shuts off the buying spirit. There were large sales of copper during March, more particularly for forward delivery in America, and it is perhaps the effect of these which is seen in the present slackening of buying. Apparently the general view here amongst copper experts is that there is no need for hurry on the part of the consumer. The market is not likely to run away from him, although fluctuations of £1 or £2 may take place. The fact that the recent movement was greater in standard copper than in refined indicates that it was largely speculative. The price of strong sheets is not now so extravagantly above that of refined copper as it was; but the consumer may still legitimately complain that he is expected to pay £10 per ton more for flat copper bottoms than for 4ft. by 4ft. sheet copper. The reason for this difference is still waiting for explanation. The upward movement in tin has not gone very far, and the view taken in the market seems to be that it is not likely to last. Many people are impressed by the fact that tin is so much cheaper than it was; but it is well to remember that the present prices are well above an average if that be taken over a long enough period. We have known tin to be well below £100 per ton for a long series of years, and there is nothing in the nature of things to lead one to suppose that this may not occur again. It is true that the consumption of the metal is much larger than it was in the 'seventies and 'eighties; but the production is also much larger, and the reserves of stock are formidable The market for lead remains very firm, and some people believe that we shall yet go back to the prices current at the beginning of the year. There are signs, however, that the Spanish strikes are coming to an end. Spelter is a fairly steady market, and so far as one can tell the prospects are in favour of slightly higher prices in the near future.

Pig Iron.

The market for foundry pig iron here is almost deserted and only a very small business is being done. Those few buyers who remain are open to buy only small lots, and they do not express any confidence in the market. Their opinion, to the effect that prices for foundry iron have still to come down, is unchanged, although it is difficult to see how pig iron can be made much more cheaply than at £4 per ton, and this is the price at some of the Midland furnaces. Most of the Derbyshire furnaces do not quote below 82s. 6d. per ton on trucks; but there have been lower offers of at least one brand of Derbyshire foundry iron. Of course, until the engineers come back to work—or it is known that they are coming back—the ironfounders of this district are unwilling to make any substantial contract for pig iron, even if they were convinced that the prices were on a rock bottom. It is always possible that the Cleveland price might be reduced, because it is certainly unnatural that Cleveland iron at the furnace should stand at 10s. per ton more than Midland iron; and perhaps if the Cleveland price were reduced to 85s. on trucks it would have some sympathetic effect here, although it would still be unable to compete in the Manchester district.

Finished Material.

Nothing is being done here now in finished iron and steel, but the nominal prices have not been changed. It is still true that there is a good deal of irregularity in the actual prices paid, and there is no doubt that many of the works give concessions where there is a chance of getting a convenient order; but officially the prices are fixed.

Scrap.

The demand for cast scrap is now smaller than ever. Dealers quote from £4 to £4 10s. per ton according to quality, and up to date one does not hear of any good cast scrap at less than £4, although one would not like to say that less has not been taken. In the other classes of scrap there has been no alteration.

Manchester Association of Engineers.

The first annual meeting of the new students' section of the Manchester Association of Engineers was held at the College of Technology on Monday, April 10th, under the chairmanship of Mr. Henry Pilling, M.I. Mech. E. The annual report states that the number of students enrolled at the end of December was 188. The attendance at the meetings of the first session is reported as having been very satisfactory, while the various lectures by experts in different subjects have proved very instructive. Much credit is due to the acting committee comprised of members of the senior section of the Association for

initiating and carrying out the arrangements for the first session, and especially are the thanks of the students due to Mr. Pilling, to whose initiative the formation of this section is largely due. Mr. Pilling has all through been the leading spirit of the movement, and has given a donation of £100, to be held in trust so that the interest on it may be utilised as the Council may determine for the purchase of prizes for the students. Henceforth the section will have to shoulder its own burden, subject to the rules of the Association, and at the meeting referred to above the first step in this direction was taken by the formation of a committee.

Salford's Electricity Supply Problem.

At a special meeting of the Salford Council, held last week, the report of the special sub-committee recently appointed to consider and report on the proposals of the Electricity Committee with regard to the appointment of a consulting engineer in connection with the electricity department was considered. The chairman of the special committee, Alderman Phillips, said that the committee could not recommend the Council to depend upon a bulk supply from an outside undertaking to meet future demands for electricity in Salford. Electric current was being generated at the Frederick-road station at 20 per cent. less cost than the present charge for a bulk supply, and the cost at the proposed new Agecroft station would be 25 per cent. less than at the Frederick-road station, owing to improved machinery running at a lower coal consumption. The committee had been advised on these points by the electrical engineer. Alderman Phillips went on to refer to the proposals of the Electricity Committee for the appointment of Mr. J. A. Robertson as engineer to design and direct the construction of the new station at Agecroft at an inclusive fee of £14,000, and his appointment for twelve months as consulting engineer in connection with the existing electricity undertaking at an inclusive fee of £500. He pointed out that Mr. Robertson would have considerable payments to make out of the former sum for an architect and other technical assistants, as well as for preparation of plans, specifications, quantities, and conditions. After some discussion it was decided that formal application should be made to the Electricity Commissioners for sanction to proceed with the Electricity Committee's scheme.

South-East Lancashire Electricity Advisory Board.

The Electricity Commissioners, after considering the evidence given at the inquiry held in Manchester in January last, respecting the formation of the South-East Lancashire Electricity Advisory Board, announce that they are prepared to make an order embodying the arrangements which the constituent authorities have agreed to carry out. It will be remembered that the district embraced by the scheme also includes parts of Cheshire and Derbyshire. It extends from Wigan on the west to the Penine Range on the east, and from Turton-Ramsbottom-Norden-Whitworth on the north to Knutaford on the south. This area has a population of over 3,000,000 and contains 10 per cent. of the electrical plant in the whole of the United Kingdom. It is the most intensely industrial area in the country. The Commissioners confirm the area provisionally determined, subject to the exclusion of Lymm and Haydock, and the inclusion of Adlington, Buxton, Macclesfield, Bollington, New Mills, Yeardsley-cum-Whaley, the rural districts of Macclesfield, Hayfield, and Disley, and a number of parishes between Chinley, Chapel-en-le-Frith, Buxton, and Miller's Dale. The undertakers and local authorities were almost unanimously opposed to the creation of a Joint Electricity Authority. Districts possessing 96 per cent. of the rateable value of the area concerned were in favour of the Advisory Board. Under the constitution of the Board every constituent authority proposing to extend or alter its plant or main transmission lines or to construct a new generating station will be required to submit to the Board plans and estimates, in order that the Board may determine if such works are in the interest of the district as a whole. The Board will have the right of making recommendations to constituent authorities upon any matter connected with the improvement and development of the supply of electricity in the district. The constituent authorities will be obliged to carry out the recommendations of the Board, subject to an important safeguard against their being involved in capital expenditure against their wishes. The Commissioners, in announcing their approval of the scheme, express some doubts on various points, such as whether certain provisions will enable sufficiently comprehensive works to be undertaken. They also point out that the number of representatives on the Board is unnecessarily large. The order will include provision for the submission by the Board of an annual report to the Commissioners.

Crisis in the Cotton Trade.

In spite of all the efforts which have been made in conference to settle the wages question in the cotton industry, no agreement between the employers and the trade unions has been arrived at, negotiations having ceased, and a complete stoppage of work on April 29th will ensue unless the slight difference between the contending parties can be adjusted. The employers' original demand was for a reduction of 75 per cent. on standard rates, or 30.6 per cent. on current rates, which is equivalent to about 6s. 1½d. in the pound. This they have now lowered to 50 per cent., or about 4s 1d. in the pound. The operatives started with an offer to accept a reduction of 25 per cent. and have now raised it to 40 per cent., or 3s. 3d. in the pound. The parties concerned in these negotiations comprise all the federated employers—spinners and manufacturers—the operative spinners and piecers, and the workers in all departments of weaving. Altogether these operatives number more than 300,000.

The Engineering Lock-out.

As the conference on the question of management, held on Friday last, came to an unsuccessful end, the position in the engineering industry is bad, and it remains to be seen whether the Employers' Federation will take any further steps. Although it is said that the A.E.U is preparing for a long struggle, I hear that many of its members have had enough of the fight and are seceding from this body.

BARROW-IN-FURNESS, Thursday.

Pig Iron.

There is no alteration in the tone of the hematite pig iron trade, but the position is full of hope. It is quite realised there are customers in plenty as soon as the lock-out and other disputes are settled. Present orders are not big, and run in hundreds of tons instead of thousands. They come oftener, but only to suit the immediate requirements of customers. Buyers are not holding back in the hope of prices falling, for the present price per ton quoted is rock bottom, and is not likely to come down for some time. There is a quiet confidence in the district that as soon as industry settles down to steady work there will be a period of briskness that has not been seen for some time.

Iron Ore.

There is just a little better trade in local ore, and one mine is working full time. Local mines will be effected by the local iron trade, and when pig iron is in greater demand the mines will equally be improved as far as business is concerned. A cargo of Spanish ore has arrived from Bilbao, and we may expect regular arrivals of ore from overseas in future.

Steel.

The steel trade is quiet and likely to be for some time, but steelmakers are optimistic, and the rail trade will probably improve when the fusion of railways is an established fact and the managements have been consolidated. At present Barrow is turning out rails, but there is not much promise of heavy orders in the near future. As in the pig iron trade, a better time is coming.

SHEFFIELD.

(From our own Correspondent.)

Holiday Week.

GENERALLY speaking, the Easter stoppage in the local engineering and steel works began on Thursday in last week, and will extend till Monday or Tuesday next—a circumstance that in itself answers the exaggerated and premature reports of a revival that have been circulated during the past few days. Sheffield, at any rate, furnishes little evidence of such a revival, though, as has recently been pointed out in this column, there is a distinctly more optimistic feeling in the air. A few of the works reopened after a comparatively brief holiday; Vickers, for instance, resumed on Wednesday, while at Steel, Peech and Tozer's and at Cammell Laird and Co.'s the steel-melting departments had only Monday as a holiday, while Sheffield Forge was among a few which closed for a couple of days. It is a satisfactory sign that the most active departments are the steel furnaces. Even there, however, the business distributed is very "patchy," for there are firms the furnaces of which were idle throughout the week preceding Easter, while, on the other hand, there were odd instances in which the men had the welcome privilege of working through the holiday period. Although from an actual selling point of view the past fortnight has been about the worst on record, there is an increasing inquiry on the part of prospective overseas customers, and there is a general expectation that with a settlement of the engineers' dispute there would be almost immediately a boom condition in local trade. At the time of writing, however, this is only a prospect, and there is little substantial foundation for rejoicing. Even the reported placing of the five million pounds' worth of Roumanian railway orders seems to have left Sheffield out in the cold so far, at any rate, as any direct interest is concerned; though if, as seems likely, Beardmore's are to get a big share of the work, Vickers, who own over 800,000 of the ordinary shares in the Glasgow concern, will doubtless provide some of the material required in the construction of the locomotives; and if, as is suggested, wagons and carriages are also to be supplied, other Sheffield firms will in all probability participate. Sheffield steel and Sheffield-made tools would almost of necessity be required on a considerable scale in the execution of any such contract.

Stainless Steel Cheaper.

A recent reduction in the price of stainless steel has further stimulated this branch, which almost alone among local industries has maintained its full activity scarcely affected by the prolonged depression. A development which will still further extend the widespread application of this steel is its manufacture in a form that gives it a certain amount of elasticity; it is claimed that a knife blade made of this material, if bent almost double, will spring back to its original shape instantly without having in any way impaired the quality of the blade. The makers claim that by using this steel for blades the percentage of "wasters" will be very considerably reduced. Makers of rustless iron are doing only a moderate amount of business. The stain-resisting nickel alloy made up into spoons and forks and many other articles of household utility, to which reference has previously been made in this column, still finds a very ready market. In the general cutlery trade, however, business is very dull.

Smaller Special Steel Export.

Sheffield cannot derive much satisfaction from the country's trading figures for the first quarter of the year, which show that special steels—in which Sheffield is more particularly interested—were exported to a total of 1016 tons as compared with 2379 tons in the first quarter of last year, and 3081 tons in the corresponding period in 1920. In iron and steel and manufactures thereof the return is more encouraging, showing a total of 772,790 tons exported, practically the same as in 1920 (773,584 tons), while last year's figure was 548,101 tons.

Unemployed and Colliery Developments.

The latest returns from the Sheffield Employment Exchange show a slight decrease in the number of persons unemployed and on short time, though the total is still just under 50,000, of whom 30,000 are men totally unemployed. The Corporation is putting in hand another big road construction scheme, which will cost about £70,000, and there are other road widening and tramways extension schemes already in hand which to some extent mitigate the distress. A few miles outside the city there is promise of work for something like seventy or eighty thousand men in connection with extensive colliery developments in North Notts. This is, however, looking rather a long way ahead, because it contemplates the completion of all the shafts now being sunk in this coalfield. There are new pits at Bolsover and Butterley, and shafts are also being sunk near Worksop and Shirebrook, and borings in various parts of the Dukeries are said to yield very promising results. At Bolsover a fine seam of coal 6ft. thick has been found at a depth of 640 yards. The new pit will be one of the most up to date in the country, and when in full working order will be capable of an output of 4000 tons per day. On the other side of the city, Newton, Chambers and Co. report the closing of their Grange Colliery, and attribute the cause partly to "the enormous cost for rates in the Rotherham area." Sheffield Gas Company has notified a further reduction in the price of gas, which is now to be 8 ½d. per therm in the case of domestic supplies, and a full penny reduction (to 8d.) for industrial purposes. This, it is stated is the lowest possible price as long as coal remains at its present figure. The coal position has not changed during the past week or two, but there is a slight hardening tendency.

NORTH OF ENGLAND.

(From our own Correspondent.)

The Trade Position.

THERE has been no material change in the industrial and trade outlook in the North of England this week. The various markets have been very quiet so far as home business is concerned, but there has been a much better tone in respect of oversea trade. Iron and steel manufacturers are now in a position to compete with continental producers, and are receiving a fair share of the orders that are being placed. In the home trade confidence has been checked by the labour disputes and new business is being withheld.

Cleveland Iron Trade.

Although there is still a considerable lack o. confidence in the outlook in the Cleveland pig iron trade, as shown by absence of interest in the forward position, the present situation can be accepted as fairly satisfactory, having regard to the disturbing influences. The whole of the output is going into immediate consumption, and the probability is that with a settlement of the industrial troubles at home and a revival of the home demand more furnaces would have to be put into operation. There is, in fact, a scarcity of iron at the moment. Most of the home foundries, it is true, are either idle or working with reduced staffs, and are consequently using very little pig iron; but the export branch of the trade is displaying a good deal of activity, and heavy shipments are being made to various parts of the world. If the engineers got back to work the position would soon vastly improve, and more iron than is at present being made would certainly be wanted. Prices all round are very firm. In view of reductions in the wages of blast-furnacemen and iron ore miners a slight revision ir pig iron prices is expected, but has not yet been made. It is pointed out that the reductions represent no more than a very small saving on a ton of pig iron, and other costs are still exceptionally high. No. 1 and siliceous iron are quoted at 95s.; No. 3 Cleveland G.M.B., 90s.; No. 4 foundry, 87s. 6d.; No. 4 forge, 85s.; and mottled and white, 80s.

Hematite Pig Iron.

The conditions in the East Coast hematite pig iron trade have not undergone any material change during the week. For the most part home consumers are operating very cautiously and are not placing any orders of great volume, being content in covering their immediate requirements. The foreign demand, however, is still quite active, and heavy shipments continue to be made to Germany and other continental countries. There has been no weakening of prices, which remain at 97s. per ton for mixed numbers and 98s. for No. 1.

Iron-making Materials.

The position in the foreign ore trade has become complicated by reason of the outbreak of a general strike at Bilbao, which is likely to affect deliveries. It is understood that all offers of best Rubio ore have been withdrawn pending a settlement of the strike. In the meantime trade is being diverted to North Africa. These latter ores, however, are firmer in price, and freights are steady at 8s. The coke market is not so strong, but no change in prices is recorded, good Durham furnace coke being still quoted at 28s. 6d. to 29s. per ton delivered at the works.

Manufactured Iron and Steel.

There are no indications of any improvement in the manufactured iron and steel trade. The shipyard strike has further accentuated the depression, and mills engaged on rolling shipbuilding material have ceased to operate. The demand for other classes of steel, such as constructional and railway material, is also extremely quiet. Manufacturers, however, show no disposition to cut prices.

The Coal Trade.

The Northern coal trade retains all its recent strength, and the outlook is regarded as very satisfactory in view of the large number of inquiries at present under consideration. The most important is that of the British Admiralty, which is in the market for 90,000 tons of best steam coals, 60,000 tons of which are required for delivery to the dockyards in regular weekly or monthly quantities over the whole of the financial year ending March 31st, 1923. Tenders have been submitted with respect to an inquiry for 45,000 tons of best steams for the Norwegian State Railways, for delivery in May and June. Another important inquiry is that of the All-Russian Co-operative Societies for the supply of 25,000 tons of best steams for shipment from the date of contract up to the end of October. Thus the bookings from May promise to be heavy. At the moment business is curtailed by reason of the scarcity of supplies caused by the closing of the pits over the holidays. All classes of Northumberland steams are firm at recent prices. The call for gas coals is as full as ever, the more so in the case of primes and specials, while for all kinds of secondary gas coals, together with every brand of coke, there is at present a very fair and an apparently improving outlet at good prices. Bunker coals are in brisk demand, and for anything in the next few weeks the prices are very firm, beats and superiors being exceptionally tight. The coke position is distinctly brighter for foundry and furnace coke, and while best beehive is steady the demand for patent oven coke is much heavier, with prices now definitely stronger. Gas coke is also a shade more inquired for, and values are moderately steady.

SCOTLAND.

(From our own Correspondent.)

Continued Depression.

THE industrial depression is as profound as ever, and there are no definite signs of improvement. As week follows week further restrictions in trade become apparent, and now buying on all hands is meagre in the extreme. In most trades the small percentage of output is more than sufficient for present needs, and still further curtailment is unavoidable. This is borne out by the report that some small colliery concerns have decided to close down until an improvement sets in and prices are again on a more remunerative basis. Better times are hinted at when the engineering crisis is at an end and business which is held up meantime comes into the market. How long it will take to restore the necessary confidence in the markets is, however, a debatable point. Buyers have waited long to discern this feeling of security, and on more than one occasion their hopes have been dispelled. Only a fuller return to pre-war levels of charges will enable home consumers, to say nothing of foreign buyers, to support home productions.

New Business.

Among the reports of general business are the following two contracts:—The Stirling Boiler Company, Glasgow, at present engaged upon the completion of boiler contracts in Edinburgh and Shanghai, has received from the Calcutta Electricity Corporation an order for two boilers of 60,000 lb. each. The cost has not been divulged, but will run into several thousands of pounds, as the boilers are of unusual size. P. and W. Anderson, Limited, Glasgow, are to commence immediately the construction of a new hall at Olympia, London, the approximate cost of which is £150,000.

Loss to Miners.

Through the withdrawal of the safety men at the mines during last year's strike, the damage done has cost to date about £250,000 to repair. Mr. M'Laren, a late Inspector of Mines, points out that under the agreement the miners were entitled to 83 per cent. of profits after certain items have been satisfied, and the miners in Scotland have lost almost £200,000 in wages already. "In other words," Mr. M'Laren said, "the losses occasioned by the withdrawal of safety men have fallen back on the workers themselves."

Pig Iron.

The output from about twelve furnaces at present in operation is more than sufficient for all demands. Despite price concessions, stocks in makers' yards continue to grow. The Glasgow pig iron "ring" met again during the week, but once again the session was a short one and no business was done.

Steel and Iron.

The position of the Scotch steel industry is as unsatisfactory as ever. A large proportion of the plants is idle, the loss of home and foreign orders being severely felt. Some concerns have done their utmost to maintain an appearance of comparative activity, but the breaking point is almost reached. Steel plates and sectional material are doing next to nothing, and it is questionable if a drastic reduction in prices would bring out an addition to business at present. Black and galvanised sheets are quiet again. Out of a fair number of inquiries received, only a very small proportion is resulting in definite orders. The latest reduction of 10s. per ton in malleable bar iron has had no effect so far. Both home and export inquiries are of little account. A little comfort is found in the report that some consumers at home and abroad have experienced trouble with the continental material, and may therefore probably be influenced in favour of British material when they are again ready for supplies. Wrought iron and steel tubes are very scarce of orders.

Coal.

The Scotch coal trade shares in the general depression. Markets are dull and supplies are in excess of requirements. Industrial concerns, railways and gas companies are purchasing in small quantities for immediate consumption, and with supplies fairly abundant prices are subjected to considerable cutting. House coal is in poor demand also, and prices are still on the decline, and to-day range from 1s. 6d. to 1s. 11d. per single cwt., according to quality. The collieries in Fifeshire and the Lothians have had fair orders to work off, and shipments still show a comparatively good total, but the drop in foreign demands is beginning to manifest itself more severely. Outputs have been good, and colliery sidings are becoming congested with wagons loaded with unsold fuel. Consequently idle time is on the increase Aggregate shipments for the past week amounted to 216,649 tons against 252,913 tons in the preceding week, and 324,572 tons in the same week in 1913. Nominal quotations show only a small reduction, but for most descriptions cheap prices can easily be arranged. Single nuts, pearls, and best navigations are the only sorts to remain firm.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Position.

THE holidays are accountable for the complete absence of any development or feature that is new in the coal trade. The conditions immediately before the vacation were very firm, and they were expected to be the same on the resumption of business; but, seeing that the men in the coalfield were not due to re-start work until the Wednesday, there was not much prospect of operations being resumed in the commercial sphere before the end of this week, particularly as the colliery salesmen were not inclined to look at fresh business for prompt shipment, as most of them had filled up their books for this month. The holidays invariably mean practically the loss of a week's output, and there is generally a disposition on the part of the colliery salesmen to hold off for the reason that they do not know exactly what coals they will have available. Many collieries are already overstemmed, so that they will require all the coal they will have produced this month to meet their obligations. The market is fully expected to keep firm for the remainder of this month and the early part of next, although many middlemen have held the view that the inquiry of late has not been sufficient to keep the market at its present level much after this month. The strike of the American miners has introduced a new factor, and although its effect at the moment is more sentimental than real, still its continuance will result in business coming to this district from Canada and other quarters usually supplied by the Americans, and this will compensate for the comparative dullness of business so far as France and Italy are concerned. Certainly coalowners and exporters are paying more attention to the possible requirements of markets which have not hitherto looked to South Wales for their needs.

Dock Working Hours.

Last week agreement for three months on dock working hours was definitely fixed up, and under this arrangement it is hoped to get a full eight hours' intensive work during each of the two shifts worked. Agreement was also come to between the employers' and the trimmers' representatives as to the hours to be worked during the holidays. One of the conditions was that on Thursday last all work was to proceed until 8 p.m., and there was also to be work on Saturday up to noon, with an hour's extension in the case of vessels that could be finished for sailing, while work was to be resumed after the holidays on Tuesday. The reason for these arrangements was that sufficient empty wagons might be provided to enable the collieries to work properly. Unfortunately, everything did not work out as had been expected, owing to the action of the tippers at Cardiff, who on Thursday last stopped work at five o'clock except in a few cases, in which they agreed to continue on up to eight o'clock where vessels could be completed ready for sea and in respect of which instances they demanded overtime payment. This action on the part of the tippers rather nullified the agreement come to. Their contention was that the agreement had nothing to do with them. The management pointed out that they were entitled to eight hours' work in the shift, and that in agreeing to close the docks at 8 p.m. they were sacrificing two hours. Furthermore, they had no authority to agree to the payment of overtime. The trimmers were not parties to the action of the tippers and were prepared to abide loyally by the agreement. At Swansea, however, both the tippers and the trimmers declined to stand by the agreement, and on Thursday suspended work at midday, with the result that a number of steamers were held up over the holidays instead of being able to finish taking in their cargoes and getting away to sea.

Docks Management.

Mr. J. H. Vickery, who is the general manager of the Alexandra (Newport and South Wales) Docks and Railway Company, and has been appointed by the Great Western Railway as the chief docks manager for this district, with headquarters at the Bute offices at Cardiff, is expected to take up his new duties on May 1st. Mr. W. Waddell, the general manager of the Barry Railway, has been appointed as docks assistant to the chief engineer.

Non-unionism.

There is the possibility of a stoppage of work in the Garw Valley, affecting about 2500 men, over the non-unionism question. Notices were recently served at the Nanthir, International, and Ffaldau Collieries, and were due to expire in the early part of this week. The whole matter was to be discussed yesterday, and an endeavour made to arrive at a decision whether work shall be continued or not; but in the meantime efforts are to be made to get all non-unionists into the Federation. It is understood that they do not form a very high percentage of the men.

Chemical Workers' Strike Off.

Intimation was received at Swansea on Saturday last from the Transport and General Workers' Union that an agreement had been arrived at with regard to the chemical workers' dispute in South Wales, and that work was to be resumed immediately. The strike has been in operation for about seven weeks, and the Swansea and Briton Ferry districts have been mainly affected. It is reported that the points in dispute are to be considered immediately after work has been re-started.

Steelworkers' Wages.

It is reported that the ascertainment of the selling price of steel bars shows further fall from £7 9s. 10½d. to £7 1s. 10½d. This means to steel workers, whose scale is based on a selling price of £5, a reduction from 23½ per cent. to just over 20 per cent.

Rumoured Amalgamation.

The report is current that negotiations are in progress for the amalgamation of the Powell Duffryn Steam Coal Company, Limited, and the Tredegar Colliery Company, Limited, but no confirmation is forthcoming. Both companies are strong and well-established undertakings. Two years ago the Powell Duffryn Company acquired the Rhymney Iron Company by an exchange of shares.

Current Business.

The coal market has not properly settled down after the holidays, and it is fully expected that matters will be very quiet until next week, when the owners will be able to gauge better what coals they will have and whether they will have any to spare. In all the circumstances prices are little more than nominal, but there is no diminution in the firmness of the market generally.

INSTITUTION OF MECHANICAL ENGINEERS.

PARIS AND LIEGE SUMMER MEETING, 1922.

AN intimation having been received from the Liége Association of Engineers that the opening of the International Scientific Congress and Exhibition which it is organising to celebrate the seventy-fifth anniversary of its foundation, has been postponed from June 11th to June 18th, to suit the convenience of his Majesty the King of the Belgians, who will perform the opening ceremonies, it has become necessary to rearrange the programme for the meeting of the Institution of Mechanical Engineers.

PROVISIONAL OUTLINE PROGRAMME (REVISED).

Monday, June 12th.—London depart for Amiens, spending the night at Amiens.

Tuesday, June 13th.—Morning: Visit Amiens Cathedral and town. Afternoon: Amiens depart by motor cars *vid* the devastated area for Compiègne, and thence proceed by train to Paris.

Wednesday, June 14th.—Morning: Business meetings. Afternoon: Visits to works. Evening: Lecture by Professor Coker.

Thursday, June 15th.—Morning: Business meetings. Afternoon: Visits to works. Evening: Institution dinner.

Friday, June 16th.—Either excursion to Fontainebleau or visits to works near Paris.

Saturday, June 17th.—Paris depart by day train for Liége.

Sunday, Monday and Tuesday, June 18th, 19th and 20th.—Liége International Scientific Congress and Exhibition, visits to works, social functions, &c.

Wednesday, June 21st.—Liége depart for London.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. FRED SHAW, late technical manager and chief designer for Messrs. W. Robinson and Co., electric hoist manufacturers, of Birmingham, has now started in business at Guildhall Buildings, Navigation-street, Birmingham, as a consulting mechanical and electrical engineer, and also as a manufacturers' agent.

CONTRACTS.—Glenfield and Kennedy, Limited, of Kilmarnock, have recently received from His Excellency the High Commissioner for the Union of South Africa, London, an order for nine large electrically operated and controlled sluice gates for the new dock and harbour extensions of the South African railways at Durban. The sizes of the gates are as follows:—One at 11ft. 6in. by 10ft.; four at 8ft. by 5ft. 3in.; and four at 6ft. by 5ft. 3in. The sluices are to be electrically operated and controlled.

PASTEUR CENTENARY.—With reference to the announcement regarding the Pasteur centenary, which was published in our issue of April 7th, we are asked to state that it is the desire of the French Committee that contributions to the proposed memorial statue, to be erected at Strasbourg, should be sent not later than June 30th next. They may be sent either to the general secretary and treasurer, Monsieur Th. Héring, 6, Rue des Veaux, Strasburg, or to Mr. A. Chaston Chapman, F.R.S., president of the Institute of Chemistry, 30, Russell-square, London, W.C. 1.

BUILDING EXHIBITION, OLYMPIA, 1922.—The following arrangements for meetings and conferences have been made for the remaining period that the Building Trades Exhibition at Olympia will be open:—To-day, at 3 p.m., Architects' Welcome Club reception; at 5.30 p.m., conference, Concrete Institute: (*a*) "Concrete Block Building," (*b*) "Reinforced Floors," (*c*) "Use of Pre-cast Work in Building Structures," by Mr. E. S. Andrews; at 7 p.m., Architects' Welcome Club banquet; and at 9 p.m., architects' ball. On Saturday, the 22nd, at 4 p.m., Institution of Sanitary Engineers. On Monday, the 24th, at 3 p.m., Institute of Clayworkers' meeting and conference: (*a*) "Gas Firing," by Dr. J. W. Mellor, Principal of the Central School of Science and Technology, Stoke-on-Trent; (*b*) "Automatic Conveyors," by Mr. Sidney Higgins; and also at 3 p.m., National Federation of Builders' Merchants Associations. On Tuesday, the 25th, at 6.p.m., "Permanent Colour Schemes in Building," by Halsey Ricardo. On Wednesday, the 26th, at 11 a.m., London Master Builders' Association; at 12.30 p.m., meeting of the National Federation of the Building and Engineering Brick Trade of England and Wales; at 4 p.m., reception of the National Federation of Building Trade Employers by the London Master Builders' Association; and at 6 p.m., lecture, "Modern Domestic Architecture: Fashion and Style," by Sir Lawrence Weaver, K.B.E.; chairman, the Right Hon. Lord Burnham. On Thursday, the 27th, at 11 a.m., London Master Builders' Association.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	28/-
(1) Spanish	28/-
(1) N. African	28/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	27/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) **Scotland—**		
Hematite	5 5 0	—
No. 1 Foundry	4 17 6	—
No. 3 ,,	4 12 6	—
N.E. Coast—		
Hematite Mixed Nos.	4 17 0	4 17 0
No. 1	4 18 0	4 18 0
Cleveland—		
No. 1	4 15 0	4 15 0
Silicious Iron	4 15 0	4 15 0
No. 3 G.M.B.	4 10 0	4 10 0
No. 4 Foundry	4 7 6	4 7 6
No. 4 Forge	4 5 0	4 5 0
Mottled	4 0 0	4 0 0
White	4 0 0	4 0 0
Midlands.		
(3) Staffs.—		
All-mine (Cold Blast)	13 0 0	—
Part Mine Forge	*None offering.*	
North Staffs. No. 3 F'dry	4 5 0 to 4 10 0	
(3) Northampton—		
Foundry Nos. 2 and 1	*Nominal.*	
,, No. 3	4 0 0	—
,, Forge	3 10 0 to 3 12 6	
(3) Derbyshire—		
No. 3 Foundry	4 2 6 to 4 5 0	
Forge	3 12 6 to 3 15 0	
(3) Lincolnshire—		
Basic	4 0 0 to 4 5 0	
Foundry	4 5 0 to 4 10 0	
Forge	4 2 6 to 4 5 0	
(4) N.W. Coast—		
N. Lancs. and Cum.		
Hematite Mixed Nos.	5 15 0	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	11 0 0	10 15 0
Best ,,	12 0 0	—
N.E. Coast—		
Common Bars	12 0 0	—
Tees	14 10 0	—
Lancs.—		
Crown Bars	12 0 0	—
Hoops	14 0 0	13 15 0
S. Yorks.—		
Crown Bars	12 0 0	—
Best ,,	13 0 0	—
Hoops	14 0 0	—
Midlands—		
Marked Bars (Staffs.)	13 10 0	—
Crown Bars	11 10 0	—
Nut and Bolt Bars	10 5 0 to 10 10 0	
Gas Tube Strip	11 10 0 to 11 15 0	
Hoops (*Nom.*)	14 0 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) **Scotland—**		
Boiler Plates	14 0 0	—
Ship Plates ¾in. and up	10 10 0	—
Sections	10 0 0	—
Steel Sheets ⅛in. to ¾in.	11 15 0	—
Sheets (Gal. Cor. 24 B.G.)	—	16 10 0

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	10 10 0	—
Angles	10 0 0	—
Boiler Plates	14 10 0	—
Joists	10 10 0	—
Heavy Rails	9 10 0	—
Fish-plates	14 10 0	—
Channels	14 10 0	—
Hard Billets	9 5 0	—
Soft Billets	7 5 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	9 10 0	—
Light ,,	11 0 0 to 13 0 0	
Billets	9 5 0	—
Ship Plates	10 10 0	—
Boiler ,,	14 10 0	—
Manchester—		
Bars (Round)	10 0 0 to 12 0 0	
,, (others)	11 0 0 to 12 0 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	12 5 0	12 0 0
Plates	£10 to 12	10 0 0
,, (Lancs. Boiler)	16 0 0	—
Sheffield—		
Siemens Acid Billets	10 0 0 to 11 0 0	
Bessemer Billets	12 10 0	—
Hard Basic	9 5 0	—
Soft ,,	7 15 0	—
Hoops	12 5 0	—
Soft Wire Rods	11 0 0	—
Midlands—		
Small Rolled Bars	9 5 0 to 9 10 0	
Bessemer Billets	7 10 0 to 7 15 0	
Hoops	11 15 0 to 12 0 0	
Gas Tube Strip	10 5 0 to 10 10 0	
Sheets (24 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets (f.o.b. L'pool)	16 0 0 to 16 5 0	
Angles	10 0 0	—
Joists	10 10 0	—
Tees	11 0 0	—
Bridge and Tank Plates	10 10 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	19/6 to 20/-
Block Tin (cash)	152 15 0
,, (three months)	154 0 0
Copper (cash)	59 0 0
,, (three months)	59 12 6
Spanish Lead (cash)	22 15 0
,, (three months)	22 5 0
Spelter (cash)	26 15 0
,, (three months)	26 15 0
Manchester—	
Copper, Best Selected Ingots	63 10 0
,, Electrolytic	65 10 0
,, Strong Sheets	88 0 0
,, Loco Tubes	0 1 1½
Brass Loco Tubes	0 0 11½
,, Condenser	0 1 2½
Lead, English	24 5 0
,, Foreign	22 15 0

FERRO ALLOYS.

(*All prices now nominal*).

	Per Ton.	Per Unit
Tungsten Metal Powder	1/6 per lb.	
Ferro Tungsten	1/4 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£27	10/-
,, 6 p.c. to 8 p.c. ,,	£26 10 0	9/-
,, 8 p.c. to 10 p.c. ,,	£25 10 0	8/-
,, Specially Refined		
Max. 2 p.c. carbon	£70	26/-
,, 1 p.c. ,,	£88	30/-
,, 0·75 p.c. carbon	£103	37/-
,, carbon free	2/- per lb.	
Metallic Chromium	5/3 per lb.	
Ferro Manganese	(per ton) £15 for home.	
,, Silicon, 45 p.c. to 50 p.c.	£13 0 0 scale 5/- per unit	
,, ,, 75 p.c.	£25 10 0 scale 6/- per unit	
,, Vanadium	20/- per lb.	
,, Molybdenum	7/- per lb.	
,, Titanium (carbon free)	1/3 per lb.	
Nickel (per ton)	£180	
Cobalt	14/- per lb.	
Aluminium (per ton)	£110 to £120 (British Official).	

FUELS.

	Export.
SCOTLAND.	
Lanarkshire—	
(f.o.b. Glasgow)—Steam	20/-
,, ,, Ell	21/6
,, ,, Splint	22/- to 24/6
,, ,, Trebles	20/-
,, ,, Doubles	19/-
,, ,, Singles	18/-
Ayrshire—	
(f.o.b. Ports)—Steam	20/-
,, ,, Splint	22/-
,, ,, Trebles	20/-
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	18/- to 22/6
Screened Navigation	26/6
Trebles	21/-
Doubles	19/6
Singles	18/6
Lothians—	
(f.o.b. Leith)—Best Steam	21/-
Secondary Steam	20/-
Trebles	20/6
Doubles	19/6
Singles	18 6
ENGLAND.	
(8) **N.W. Coast—**	
Steams	33/-
Household	40/- to 55/-
Coke	34/-
Northumberland—	
Best Steams	23/- to 24/-
Second Steams	22/- to 22/6
Steam Smalls	14/- to 15/
Unscreened	21/6
Household	25/- to 30/-
Durham—	
Best Gas	23/-
Second	21/- to 22/-
Household	25/- to 30/-
Foundry Coke	32/6 to 35/-
Sheffield—	**Inland.**
S. Yorks. Best Steam Hards	22/- to 23/- —
Derbyshire Hards	21/- to 22 - —
Seconds	20/- to 21/- —
Cobbles	19/- to 20/- —
Nuts	17/- to 18/- —
Washed Smalls	11/- to 12/- —
Best Hard Slacks	12/- to 13/- —
Seconds ,,	10/- to 11/- —
Soft Nutty ,,	9/- to 10/- —
Pea ,,	7/- to 8/- —
Small ,,	4/- to 5/- —
House, Branch	37/- to 39 - —
,, Best Silkstone	34/- to 35/- —
Blast Furnace Coke (Inland and Export)	17/6 to 22 6
Cardiff—	**(9) SOUTH WALES.**
Steam Coals:	
Best Smokeless Large	28/6 to 29/-
Second ,, ,,	28/- to 28/6
Best Dry Large	26/6 to 27/6
Ordinary Dry Large	24 6 to 25/6
Best Black Vein Large	27/6 to 28/-
Western Valley ,,	27/- to 27/6
Best Eastern Valley Large	27/- to 27/6
Ordinary ,, ,,	24/6 to 25/6
Best Steam Smalls	19/- to 20/-
Ordinary ,,	15/- to 19/-
Washed Nuts	27/6 to 30/-
No. 3 Rhondda Large	30/- to 32/6
,, ,, Smalls	19/6 to 20/-
No. 2 ,, Large	24/6 to 26/-
,, ,, Through	20/- to 22/-
,, ,, Smalls	16/6 to 18/-
Coke (export)	30/- to 35/-
Patent Fuel	24/6 to 27/6
Pitwood (ex ship)	30/- to 31/-
Swansea—	
Anthracite Coals:	
Best Large	32/6 to 35/-
Seconds	28/- to 30/-
Red Vein	28/- to 30/-
Big Vein	32/6 to 35/-
Machine-made Cobbles	45/- to 47/6
Nuts	47/6 to 50/-
Beans	47/6 to 50/-
Peas	24/- to 25/-
Breaker Duff	10/- to 10/6
Rubbly Culm	15/- to 16/-
Steam Coals:	
Large	21/- to 24/-
Seconds	20/- to 22/6
Smalls	15/- to 18/-
Cargo Through	18/6 to 20 -

(1) Delivered. (2) Net Makers' works. (3) At furnaces. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—F.O.B. Glasgow.

(8) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

French Engineering Notes.

(From our Correspondent in Paris.)

Ad Valorem Duties.

THE importer finds it very difficult to determine exactly the cost of goods when the methods of imposing duties constantly vary, with the object of bringing them into harmony with the fluctuating conditions of exchange. This uncertainty has a serious effect upon foreign business, since the consumer hesitates to buy when he finds that the cost may be increased by a variable quantity, while the agent is unable to rely upon his margin of profit. The situation is not so bad in the case of goods assessed by weight, as the multiplication of the pre-war tariff by a coefficient which is supposed to provide for the depreciated exchange—but, as a matter of fact, often does much more—allows of a basis for the fixing of prices once the goods arrive in the country. The only uncertain factors are the accessory expenses and the possibility of coefficients being changed at any time to meet urgent cases. At the present moment, the revision of the coefficients is embarrassing for the future, since no one knows in what way they will be modified, and it is understood that they are being held up pending the outcome of the Genoa Conference. If weight provides a fairly stable basis for valuation, the fixing of the duties *ad valorem* considerably widens the range of appreciation, and apparently its elastic character is to be taken full advantage of by the Customs. As a general rule, the importer believes that the duty is imposed upon the amount of the invoice which he has to produce. This is done when the verifiers are of the opinion that the amount of the invoice corresponds approximately with the commercial value of the goods. Importers, however, may now expect to see the duties imposed to the fullest extent allowed by the regulations, which provide that the tax shall be paid upon the commercial value of the goods at the time and place of importation, without counting the amount of duty. In other words, it does not necessarily follow that the verifier will accept the value declared according to the amount of the invoice, to which must be added the freight and other charges, but he may fix the value of the goods according to the actual value of similar goods manufactured or sold in the country. This entirely upsets the generally accepted ideas of the operation of the tariffs. Importers had always believed that a reduction in the price of an article in its country of origin would mean a corresponding reduction in the duty, but according to the interpretation which is likely to be adopted in the future, the goods will be considered as having the same commercial value as similar articles of French manufacture. It really, therefore, means a considerable increase in the import duties on goods from countries with a depreciated currency, and will not affect to anything like the same extent goods imported from Great Britain, where the cost of production can hardly be inferior to what it is in this country.

Trade Stability.

One of the results of the instability of trade is the unsatisfactory position with regard to Spain, Italy and other countries which have refused to accept the French conditions for commercial arrangements, and have adopted measures of retaliation that have put an almost complete stop to business. Since the rupture with Spain three months ago, France has lost something like 500 million francs, and the total loss resulting from the operation of the present fiscal policy must be considerable. The French are more than ever anxious to come to terms with those countries, for despite their relatively favourable commercial situation they cannot afford to lose a valuable foreign trade, especially when the home trade depends so largely upon a problematic solution of the reparation problem. Their ideas upon the reparation are undergoing a change. They see that the policy being adopted towards Germany is likely to produce results quite different from what they had expected. Their refusal to accept any modification of the reparation arrangements is being tempered by a growing conviction that the situation in Germany is not what it is generally represented to be. It is true that there is as much industrial activity in Germany to-day as ever before, but as the country is losing on what it sells the position is becoming increasingly hopeless, and the French are therefore beginning to see that by holding aloof from any attempt to bring about a general reconstruction they are not serving their own interests.

Train Ferry Boat.

While most of the railway companies are carrying out a great deal of improvement work, especially in the way of electrification, the State Railways have been obliged to go in for an extensive scheme of reconstruction in order to give a satisfactory degree of efficiency to a system which has always been lacking in suitable equipment. Besides the re-laying of some of the existing lines, it is proposed to construct others from Havre to Pont de l'Arche and from Lillebonne to Pont-Audemer. The latter would pass under the mouth of the Seine, if it were found possible to drive a tunnel, over a length of 8 kilom., but soundings have shown that the rapid infiltration of water at shallow depths would make the work very difficult, and it has therefore been suggested to replace the tunnel with a train ferry.

Pulverised Coal.

At a time when the high price of coal compelled users to look to other kinds of fuel, it was hoped that considerable economies would be realised with the employment of heavy oils for steam raising. The limited supplies of crude oils, however, soon revealed the fallacy of relying upon liquid fuels for this purpose, and attention was therefore directed to pulverised coal. For a long while past experiments have been carried out with pulverised coal for raising steam in the electrical generating plants at the Bruay Collieries in the Nord. The early attempts were somewhat disappointing, but an improved installation has now been laid down which is said to be giving perfect satisfaction.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

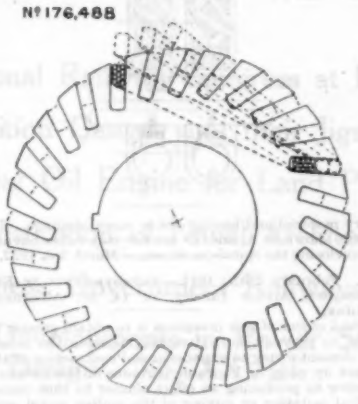
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

DYNAMOS AND MOTORS.

176,488. December 6th, 1920.—IMPROVEMENTS IN DYNAMO-ELECTRIC MACHINERY, Henry Francis Joel, sen., of 122, Telbrigge-road, Goodmayes, Essex, and Henry Francis Joel, jun., of 39, Beckenham-road, Beckenham, Kent.

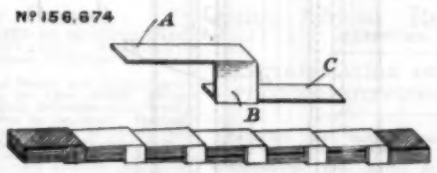
As clearly shown in the drawing, the slots in the laminated core of an armature are, according to this invention, punched out at an angle, and by first placing the lower side of the coil in its



appointed slot and simply turning the coil in that slot, the top and parallel side of the coil fits easily into its proper slot without strain or distortion. Various other advantages are claimed for the invention. There are three other illustrations.—*March 6th, 1922.*

156,674. January 6th, 1921.—CONDUCTORS FOR ELECTRIC MACHINES CONSISTING OF SEVERAL MEMBERS CONNECTED IN PARALLEL, Bergmann-Elektricitäts-Werke Aktiengesellschaft, of Seestrasse 64-67, Berlin, Germany.

This invention relates to the prevention of eddy currents in the conductors of electrical machines. Each conductor is formed of six component members of rectangular cross section. Each of these members consists of two bent or relatively displaced parts A C, the bridge B connecting the two parts being bent so as to lie flat against the other members and to displace the position of this member relatively to the whole group

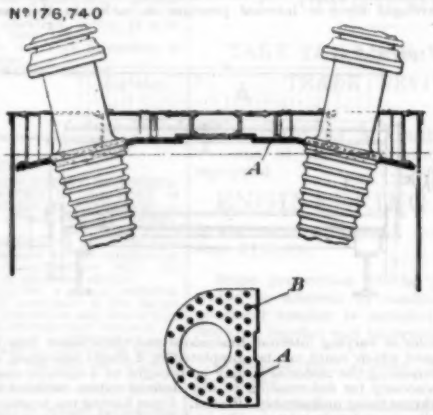


of conducting members. The change of position of the conducting members is uniformly distributed over the whole length of the conductor. As is more particularly shown by the shading of one of the conducting members, by this arrangement each member in succession takes up the uppermost position and the different members in this respect are all similar, since each one in turn has the same position as all the others. Any differences of potential and consequent equalising currents between the separate members of a conductor are by this arrangement avoided.—*March 16th, 1922.*

SWITCHGEAR.

176,740. December 3rd, 1920.—IMPROVEMENTS IN AND RELATING TO ELECTRIC SWITCHES, *The British Thomson-Houston Company, of 83, Cannon-street, E.C.*

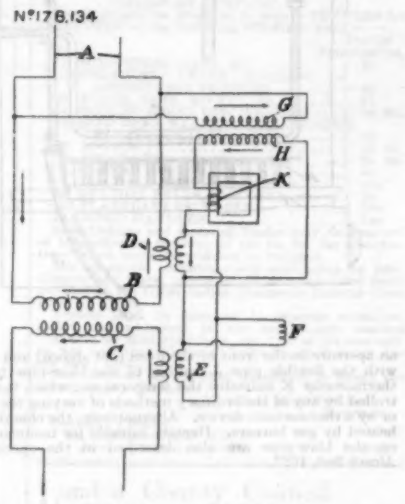
The object of this invention is to cool the gases formed at the contacts of switches and to prevent heated particles being projected into the air. For this purpose baffling members A are provided. Preferably these members are made in sections, and



in the case illustrated there are three sections. The baffling member consists of two plates with openings B, and between the plates there is a wire screen, which naturally covers the openings B. When the contacts of the switch separate, gases are formed within the oil. The oil level rises and submerges the baffling members. The passage of the oil through the openings B causes the gases to be broken up and cooled, so that they do not ignite the gaseous mixture in the space above the oil. Moreover, owing to the provision of the wire screen, no heated particles of metal can be thrown off.—*March 3rd, 1922.*

176,134. December 1st, 1920.—IMPROVEMENTS IN AND RELATING TO METHODS OF PROTECTING ELECTRIC TRANSFORMERS, The British Thomson-Houston Company, of 83, Cannon-street, and Henry Stanley Holbrook, of 34, Lancaster-road, Rugby.

The supply mains A are connected to the primary B of a main power transformer, and the secondary C supplies current to the load. In the primary circuit is the current transformer D, and in the secondary circuit the current transformer E, the secondary windings of these current transformers being connected in series in the usual manner for circulating current protection. Across this latter sub-circuit is shunted the tripping circuit F. In parallel with the primary B of the main

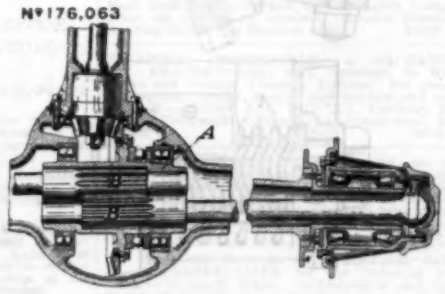


power transformer, the primary G of a potential transformer is connected, and the secondary H of this transformer supplies current to a circuit, including a reactor K and the secondary of the current transformer D, which is in the primary circuit of the main power transformer. With this arrangement, the specification states, no current will flow in the tripping circuit as the result of variation in the supply voltage or the load, except when there is an internal fault in the transformer. Kicking fuses or other biasing devices are unnecessary, and the limit of the sensitiveness of the system is determined by the characteristic of the relay.—*March 1st, 1922.*

TRANSMISSION OF POWER.

176,063. November 2nd, 1920.—DIFFERENTIAL GEARING, A. E. Jerram, 16, Chatham-street, Leicester.

The cage A of this gear is bored out, with two slightly inclined parallel holes, to take the toothed ends B B of the driving axels or shafts. The outer ends of the shafts are provided with

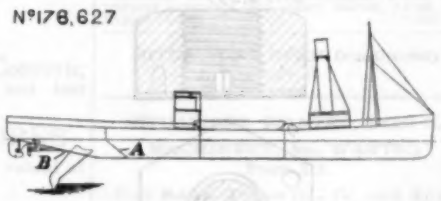


universal joints. The cage A runs in ball bearings, and is driven in the usual manner by bevel gearing. The toothed parts B B of the shafts, it will be seen, take the place of the planet wheels in the usual type of differential gear.—*March 2nd, 1922.*

SHIPS AND BOATS.

176,627. February 9th, 1921.—STERN WELL DREDGERS, Sir F. Lobnitz, Ross Hall, Crookston, Renfrewshire, and Lobnitz and Co., Limited, Renfrew.

In order to reduce the resistance to propulsion of stern well dredgers the inventors incline the forward end of the well, as



shown at A and make the bottom of the hull slope upwards towards the water line, as indicated at B. The result is a smaller wetted surface than is usual, while the abrupt corners of the square well are done away with.—*March 10th, 1922.*

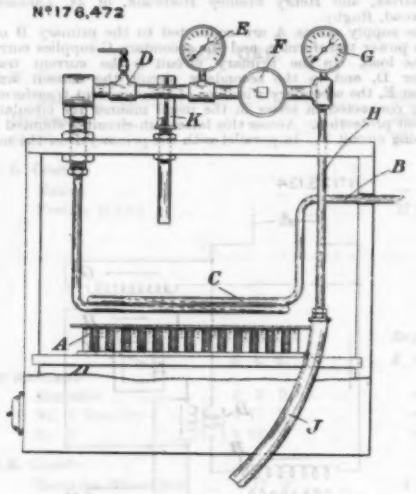
MACHINE TOOLS AND SHOP APPLIANCES.

176,472. December 2nd, 1920.—CUTTING METALS BY OXYGEN, A. Godfrey, the Godfrey Engineering Works, Boundary-road, Westbury-avenue, London, N. 22.

The inventor says that he has found that heating the oxygen used in a cutting blow-pipe to a temperature of 180 deg. Fah. greatly improves the efficiency of cutting. He thus passes the

oxygen through a heating apparatus, such as that shown in the figure, on its way to the blow-pipe. Heat is provided by an electric heater A of the resistance type. The pipe B leads the oxygen under pressure to a coil C. From the coil it is led outside the oven to a cock D, high-pressure gauge E, reducing valve F, and working pressure gauge G. The gas under working pressure is then again led through the oven by the pipe H, which may include a further coil if desired. This pipe is brought out through

N°176,472



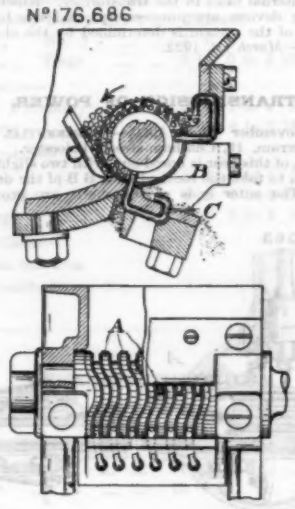
an aperture in the front of the oven (not shown) and connected with the flexible pipe J leading to the blow-pipe burner. A thermometer K indicates the temperature, which may be controlled by any of the ordinary methods of varying the resistance or by a thermostatic device. Alternatively, the chamber may be heated by gas burners. Heaters suitable for mounting directly on the blow-pipe are also described in the specification.—*March 2nd*, 1922.

CRUSHING AND GRINDING.

176,686. April 1st, 1921.—GRINDING MILLS, J. Mohs, 28, Wasserstadt, Dessau, and Deutsche Werke Aktiengesellschaft, 12A Bellevuestrasse, Berlin, W. 9.

In this mill the granulating rings A A have a sinuous form as shown, and are spaced a short distance apart on their shaft.

N°176,686



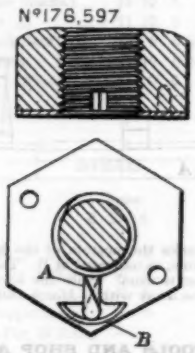
Pegs B are arranged to project into the grooves to prevent the passage of unground material, and are pivoted at C to permit their following the undulations of the grooves.—*March 16th*, 1922.

MISCELLANEOUS.

176,597. January 25th, 1921.—A NUT LOCK, J. A. Stubblefield, 507, Williams-avenue, Portland, Oregon.

In this lock nut a little pawl A is arranged in a recess in the nut, where it is kept by a cover plate, and is held up against the threads of the bolt by a spring B. When the nut is screwed on

N°176,597

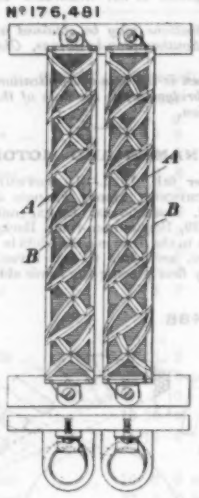


to the bolt the pawl takes up the position shown and resists the unscrewing of the nut. It can, however, be moved over to the opposite position, shown dotted, if the nut is unscrewed by a spanner, on account of the flexibility of the spring.—*March 16th*, 1922.

176,481. December 3rd, 1920.—AN IMPROVED ELECTRIC HEATING ELEMENT, Automatic and Electric Furnaces, Limited, and John Percival Coleman, both of 281-283, Gray's Inn-road, London.

The heating element described in this specification comprises spirals of wire enclosed by a tubular support composed of a

N°176,481

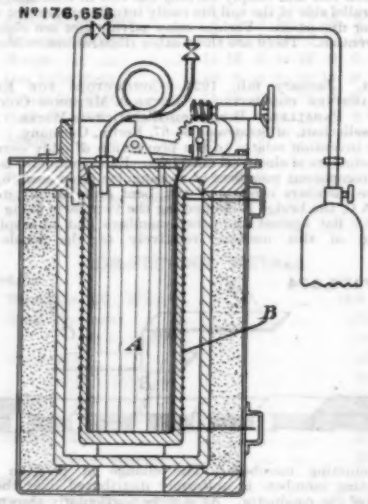


refractory material and having one or more openings. The wire spirals are shown at A, and B are fire-clay tubes having opening and enclosing the spirals as shown.—*March 3rd*, 1922.

176,658. February 28th, 1921.—IMPROVEMENTS IN ELECTRIC FURNACES, Arthur Imbery, of 14, St. Alburns-avenue, Halifax.

The chief object of this invention is to obtain greater thermal efficiency, to prevent short-circuiting between the coils of the heating element owing to expansion and contraction of the coils, and to set up eddy or Foucault currents in the molten metal, with a view to producing an effect similar to that caused by a mechanical agitation or mixing of the molten metal and which

N°176,658

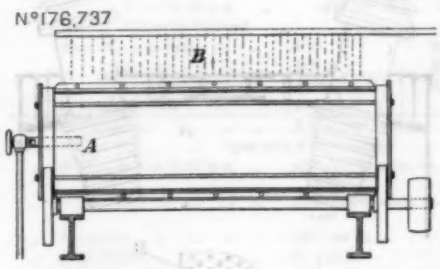


results in the production of an extremely uniform metal. The furnace chamber A is made of silicon carbide serrated or threaded on its outer surface to receive a coil of wire or strip B, which is constructed from molybdenum or molybdenum alloy, and is situated in a chamber containing inert gas, such as hydrogen. To obtain the eddy current effect it is essential to use alternating-current supply.—*March 16th*, 1922.

176,737. October 30th, 1920.—CENTRIFUGAL CASTING, H. P. Amphlett and the Hume Pipe and Concrete Construction Company, Limited, 70, Lower Belgrave-street, Victoria, S.W. 1.

This invention is concerned with a development of the centrifugal method of casting pipes, specially as applied in the making of vitreous pipes from a mixture of slag, caustic soda, &c. A hollow cylindrical object or blank formed in one mould is transferred to another mould, where, in a reheated condition, it is formed to a more complicated shape, either by the action of centrifugal force or internal pressure or both. In this way

N°176,737



articles of varying internal dimensions and thicknesses may be formed which could not be completed in a single operation, as in reheating the material it may be brought to a suitable state of viscosity for deformation to any desired extent without its thickness being undesirably affected. Pipes having tee junctions or elbows or bends may readily be formed in the manner indicated. The illustration represents the re-moulding machine with a gas heater at A and a cooling spray B.—*February 28th*, 1922.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INSTITUTE OF TRANSPORT.—Royal Society of Arts, John-street, Adelphi, W.C. 2. Lecture: "The Operation of a Large Tramway Undertaking, with reference to Capacity and Cost Under Given Conditions," by Mr. J. K. Bruce. 5 p.m.

THE JUNIOR INSTITUTION OF ENGINEERS.—Caxton Hall, "Condenser and Choke Coil Protective Apparatus," by S. A. Stigant. 8 p.m.

THE INSTITUTION OF PRODUCTION ENGINEERS.—Institution of Mechanical Engineers, Storey's-gate, S.W. 1. Paper, "Electricity in a Machine Shop" (slides), by Mr. J. R. Smith. 7.30 p.m.

TUESDAY, APRIL 25TH.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. Lecture, "Anthropological Problems of the British Empire: Series II., Racial Problems of Africa," by Sir Arthur Keith. 3 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. 1. Annual general meeting of corporate members only. 6 p.m.

WEDNESDAY, APRIL 26TH.

SOCIETY OF GLASS TECHNOLOGY.—Royal Victoria Station Hotel, Great Central Railway, Sheffield. Fourth annual dinner. 7 p.m. for 7.15 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. 2. "The Use and Advantages of Electric Power in the Factory, as illustrated by its Application to the Jute Industry," by Mr. John Francis Crowley, D.Sc., B.A., M.I.E.E. 8 p.m.

LIVERPOOL ENGINEERING SOCIETY.—Royal Institution, Colquitt-street, Liverpool. Annual general meeting. 8 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. Lecture, "Industrial Relationships," by Professor D. H. MacGregor. 3 p.m.

THE INSTITUTE OF PHYSICS.—Institution of Civil Engineers, Great George-street, Westminster, S.W. 1. Lecture: "Physics and Engineering Science," by Professor Archibald Barr, D.Sc., F. Inst. P. 8 p.m.

THURSDAY, APRIL 27TH.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, W.C. 2. "Protective Appliances for Turbo-alternators," by Mr. J. A. Kuyser. 6 p.m.

THE SOUTH-WESTERN POLYTECHNIC INSTITUTE.—Manresa-road, Chelsea, S.W. 3. A short course of ten lectures on "Chemistry and Technology of Petroleum" will be delivered by Mr. Fred Ealing, B.Sc., A.C.G.I., A.I.C., M. Inst. P.T., on Thursday afternoons, at 2 p.m.

THE ILLUMINATING ENGINEERING SOCIETY.—The Royal Society of Arts, John-street, Adelphi, W.C. 2. Discussion on "The Use of Light in Hospitals." 8 p.m.

THE NEWCOMEN SOCIETY.—Caxton Hall, Westminster, S.W. 1. Papers, "A Note on Brunton's Walking Engine, 1813," by Mr. Loughnan St. L. Pendred, M.I. Mech. E.; "A Note on Heaton's Steam Carriage, 1828," by Mr. A. Titley, M.I. Mech. E.; "Gurney's Railway Locomotives," by Mr. E. A. Forward, A.R.C.S. 5 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. Lecture, "Audition and Colour Vision," by Mr. Edwin H. Barton, D.Sc. 3 p.m.

LIVERPOOL ENGINEERING SOCIETY.—Royal Institution, Colquitt-street, Liverpool. Students' meeting. Paper, "The Uniflow Steam Engine," by Mr. E. Cockshutt. 7.30 p.m.

FRIDAY, APRIL 28TH.

INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—The Technical Institute, Dundee. Paper: "Single and Three-phase Alternating-current Commutator Motors with Series and Shunt Characteristics," by Professor S. Parker Smith. 7.30 p.m.

INSTITUTION OF AERONAUTICAL ENGINEERS.—The Engineers' Club, Coventry-street, W. 1. Paper, "Some Unsettled Problems of Aeroplane Design," by Captain Sayers. 6 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster, S.W. 1. "An Account of Some Experiments on the Action of Cutting Tools," by Professor E. G. Coker and Mr. K. C. Chakko, D.Sc. 6 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. Discourse, "Vitamine Problems," by Mr. Arthur Harden, D.Sc. 9 p.m.

SATURDAY, APRIL 29TH.

THE INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Eastern District Meeting of the Institution will be held at Chiswick. 10.30 a.m.

WEDNESDAY, MAY 3RD.

INSTITUTE OF METALS.—Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. 1. General meeting. The twelfth annual May lecture on "The Relation of the Elements," by Professor Sir Ernest Rutherford, F.R.S. 8 p.m.

THURSDAY, MAY 4TH.

IRON AND STEEL INSTITUTE.—Connaught Rooms, Great Queen-street, London, W.C. Annual dinner. 7 for 7.30 p.m.

THE INSTITUTION OF LOCOMOTIVE ENGINEERS (LONDON).—Engineers' Club, 39, Coventry-street, W. 1. Paper, "Comparison between Superheated and Non-superheated Tank Engines," by Mr. J. A. Hookham. 7.15 p.m.

ASSOCIATION OF RAILWAY COMPANIES' SIGNAL SUPERINTENDENTS AND SIGNAL ENGINEERS.—Railway Clearing House, London. Sixty-fourth Conference.

THURSDAY AND FRIDAY, MAY 4TH AND 5TH.

IRON AND STEEL INSTITUTE.—Institution of Civil Engineers, Great George-street, S.W. 1. Annual meeting.

FRIDAY, MAY 5TH.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W. 1. Informal meeting. Subject, "Failures." 7 p.m.

TUESDAY, MAY 30TH, TO FRIDAY, JUNE 2ND.

INSTITUTION OF ELECTRICAL ENGINEERS.—Summer Meeting in Scotland. Ladies invited. For programme, see page 326.